ANTIMICROBIAL ACTIVITY OF Moringa oleifera: A SHORT REVIEW

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ABSTRACT
Moringa oleifera Lam. (Family Moringaceae) is well known for its various medicinal properties. It grows wild in the tropical and subtropical areas of Asia, Africa and the Middle East. In Nigeria, Moringa oleifera trees are planted at a large scale especially in the northern part of the country. It has been widely used in the treatment of certain diseases as a traditional medicinal herb. Antimicrobial activity is the most studied property of Moringa oleifera. Many studies have shown that nearly all types of Moringa oleifera tissues exhibit antimicrobial activity including antibacterial, antifungal, antiviral and anti parasitic property. This review describes progress on research conducted to understand the antimicrobial activity of Moringa oleifera and discusses the potential use of Moringa oleifera in the control of pathogenic microbes.
Key words: Antimicrobial activity; Moringa oleifera; pathogenic microbes, control.

INTRODUCTION
During the last decades, the limit of microbial diseases and infections has been exceeded drastically (Wael et al., 2015). A persistent problem in antimicrobial chemotherapy is the increasing occurrence of resistance to antibiotics, which leads to the recalcitrance of antimicrobial treatment (Wael et al., 2015). The continue usage of antibiotics and consequent antibiotic selection pressure is thought to be the most crucial factor contributing to the appearance of several kinds of resistant microbes (Sokovi et al., 2010; Bajpai et al., 2013). Discovery of novel antimicrobial agents/herbal medicine is very crucial for the control of pathogenic microbes, especially for the therapy of infections caused by recalcitrant microbes. Medicinal herbs with antimicrobial activities are considered a potent source of novel antimicrobial function (Wang et al., 2016). Moringa oleifera is a woody tree mainly distributed in the tropical and subtropical regions of Asia, Africa (including Nigeria) and the Middle East (Leone et al., 2015). Moringa oleifera is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal usage with high nutritional contents. Different tissues of this plant contain a profile of important antimicrobial agents (Bukar et al., 2010). Various parts of the plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods have various antimicrobial activities such as antibacterial activity (Dzotam et al., 2016; Zaffer et al., 2014), antiparasitic activity (Kaur et al., 2014), anti fungal (Zhao et al., 2012), antiviral (Chollom 2012).

Previous studies have shown Antimicrobial activity which has been studied thoroughly in Moringa oleifera. However, Crude extracts of different part of Moringa oleifera possess different kind of antimicrobial activities. In this paper, the main aim is to review the research progress in understanding and characterizing the antimicrobial activity of Moringa oleifera tissues including antibacterial, antifungal, antiviral, and antiparasitic activity, and highlight the potential use of Moringa oleifera in the control of pathogenic microbes.

Antibacterial Activities of Moringa oleifera
Antibacterial activity of Moringa oleifera has been shown in different studies. Using the Disc agar diffusion technique, Bukar et al. (2010) evaluated the antibacterial activity of Moringa oleifera leaf and seed chloroform and ethanol extracts. One Gram-positive bacterium (Staphylococcus aureus) and six Gram-negative bacteria (Escherichia coli, Salmonella typhi, Enterobacter aerogenes, Salmonella typhimurium, Shigella spp and Pseudomonas aeruginosa) were used to test the antibacterial activities of Moringa oleifera.
The result of *M. oleifera* leaf ethanol (MLE) extracts show that it had activity against four bacterial isolates. Enterobacter spp, *P. aeruginosa* and *E. coli* were sensitive while *Shigella* spp, *S. typhi* and *S. typhimurium* were not sensitive at all the concentrations used. *M. oleifera* leaf chloroform (MCL) was active on *E. coli*, *S. typhimurium* and *S. typhi*. Similarly, *Moringa oleifera* seed ethanol (MSE) extract was active against three bacterial isolates (*S. aureus, E. coli* and *S. typhi*). Enterobacter spp, *Shigella* spp, *P. aeruginosa* and *S. typhimurium* were not sensitive to any of the concentrations tested. *Moringa oleifera* seed chloroform (MSC) extract was active against two bacterial isolates (*E. coli* and *S. typhimurium*). Enterobacter spp, *Shigella* spp, *P. aeruginosa* and *S. typhi* were not sensitive to any of the concentrations tested.

Similarly, Using agar well diffusion method, Lar et al., 2011 found the antibacterial activity of ethanol and aqueous extracts of dried *Moringa oleifera* seeds using three gram negative organisms, *Escherichia coli, Shigella flexneri* and *Salmonella typhi*. The aqueous extract had no effect on the test organisms at the various given concentrations, but there was appreciable antimicrobial activity demonstrated by the ethanolic seed extract with *Escherichia coli* and *Shigella flexneri* being susceptible. *Salmonella typhi* showed no susceptibility to both extracts.

The experiments carried out by Bijal and Bhumika (2015) confirmed that the Ethanol, Methanol, Petroleum ether & Aqueous extracts of *Moringa oleifera* leaves showed different inhibition patterns. The result reveals that solvent extracts of the different parts of *Moringa oleifera* (Leaves, Flower, Pulp and Seed) were active against *E. coli* and *S. aureus*. It was suggested that *Moringa oleifera* leaf extracts might be used in the control of many infectious diseases alone or together with other antibiotics (Dzotam et al., 2016). In addition, Khanitta and Angelika (2015) determine antibacterial activities of three different extracts; i) cold water extract of *Moringa oleifera* seed powder, ii) cold water extract of MO residue after oil extraction by Soxhlet method and iii) *Moringa oleifera* seed oil obtained by Soxhlet method were determined using the diffusion technique of Bauer-Kirby (disk method). MO seed oil is active against all the tested isolates (*Staphylococcus aureus, Bacillus subtilis, Salmonella typhimurium, Enterobacter aerogenes* and *Pseudomonas aerogonosa*). Similarly, Extracts of MO seed powder and MO residue are active against all the above bacterial isolates with the exception of *Staphylococcus aureus*.

The experiments carried out by Patel and Mohan (2018) confirmed that the different tissue extracts of *Moringa oleifera* showed different inhibition patterns against different bacterial strains. The tested organisms are *Bacillus cereus, Bacillus subtilis, Enterococcus faecalis, Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginos*, *Serratia marcescens, Salmonella paratyphi, Salmonella typhi*.

In another recent study by Bichi and Shehu 2018 using Agar well diffusion method. The hexane crude extract of *Moringa oleifera* seeds oil exhibited clear antibacterial activity against *E. coli* and the *M. oleifera* seed oil gave average zones of inhibitions of 17.7mm, 14.3mm, 11.3mm, and 9.0mm for the 100%, 75%, 50%, and 25% respectively.

**Antifungal Activities of *Moringa oleifera***

Many studies have highlight that different crude extracts from different tissues of *Moringa oleifera* possess antifungal activities against fungi. Bukar et al. (2010) evaluated the antifungal activity of *Moringa oleifera* leaf and seed chloroform and ethanol extracts. The result of the study showed that MSC inhibited the growth of *Mucor* spp and *Rhizopus* spp by 100% at 1000 µg/ml while MSE inhibited growth of *Mucor* spp by 75% and *Rhizopus* spp by 50% each at 1000µg/ml concentration. MLC inhibited the growth of *Mucor* spp and *Rhizopus* spp by 25% at 1000 µg/ml while MLE inhibited growth of *Mucor* spp by 50% and *Rhizopus* spp by 100% each at 1000µg/ml concentration. According to this study, it could be observed that MSC proved to be the extract with the best antifungal activity on the test fungi as it prevented completely the growth of both *Mucor* spp and *Rhizopus* spp at 1000µg/ml. Using Agar well diffusion method, Pinal et al., (2014) showed the Antifungal activity of *Moringa oleifera* leaf extracts against several fungi namely *Saccharomyces cerevisiae, Candida albicans* and *Candida tropicalis*. The ethanol and aqueous leaf extract result showed activity against *Saccharomyces cerevisiae* and *Candida tropicalis* but no activity was observed in *Candida albicans*. The largest zone of inhibition was produced by water and ethanol extract of *Moringa oleifera* against *Saccharomyces cerevisiae.*
Aspergillus niger, Aspergillus paracitic, Candida Albicans, Aspergillus flavus, Trichoderma harzanium, Alternata burnsi, Fusarium oxysporum. According to the experiment carried out by Patel (2016). The result indicated that, the crude extracts of M. oleifera showed susceptibility of all the fungal strains to both the ethanol and water extracts.

In a recent study by Aondo et al., (2018), mycelia growth of Aspergillus flavus was found to be inhibited by the extract of Moringa oleifera (Bark seed and Leaf) Crude extracts. This antifungal property of Moringa oleifera can prevent culture media contaminations by some saprophytic fungi. The result showed ethyl acetate, Methanolic, ethanolic and water extract of Moringa oleifera leaves, seeds, bark were found to be effective against the fungi.

According to the experiment carried out by Patel and Mohan (2018) confirmed that the different tissue extracts of Moringa oleifera showed different inhibition patterns against different fungal strains. The tested fungal isolates include Aspergillus niger, Aspergillus paracitic, Candida Albicans, Aspergillus flavus, Trichoderma harzanium, Alternata burnsi, Fusarium oxysporum.

Anti parasitic Activity of Moringa oleifera

Leishmania is a genus of trypanosomes that are responsible for Leishmaniasis disease (Wang et al., 2014). Kaur et al., (2014) showed that 70% ethanolic extract of Moringa oleifera roots exhibit antileishmanial activity with IC50 values of 83 µg/ml and the methanolic extract of leaves showed antileishmanial activity with IC50 values of 47.5 µg/ml.

Harvie and Delfin (2017) demonstrate the anthelmintic activity of M. oleifera seed ethanolic (MSEE) and aqueous (MSAE) extracts against the eggs and larvae of Haemonchus contortus. The result showed that with the exception of the larvicidal activity of MSAE, the rest of the M. oleifera seed extracts displayed its anthelmintic activity in a dose-dependent manner.

In another experiment carried out by Hegazi et al., (2018), they showed ovicidal effects of the different M. oleifera extract on the Fasciola gigantica Eggs. The result of M. oleifera alcoholic and aqueous extracts, as well as nitroxylin, showed an ovicidal effect on Fasciola non-embryonated and developed eggs. LC50 was higher in non-embryonated eggs than developed eggs for methanolic and ethanolic extracts. Water extract exhibited a different effect as LC50 of aqueous extract on developed was higher than that of non-embryonated eggs.

In many developing countries including Nigeria, irrigation water is widely used in urban farming, which can get polluted by the helminth parasite and their eggs. Sengupta et al., 2012 showed that Moringa oleifera seed extracts could reduce helminth eggs and turbidity in irrigation water. It is well known that Moringa oleifera seeds have been widely used in water purification for a long time in underdeveloped countries.

Antiviral Activity of Moringa oleifera

Foot and mouth disease (FMD) is terribly disease caused by a virus named picornavirus (Ishrat et al., 2015). In a research by Ishrat et al. (2015) on Antiviral assay of Moringa oleifera alcoholic leaves extracts at eight concentrations (1 µg/ml, 6 µg/ml, 12 µg/ml, 25 µg/ml, 50 µg/ml, 100 µg/ml, 200 µg/ml and 400 µg/ml respectively) had revealed cell survival percentages in the range of 14% to 74%. The results had indicated that first six concentrations up to 100 µg /ml had antiviral activity against FMDV as cell survival was found above 50% whereas 200 µg/ml and 400 µg/ml did not resulted in antiviral activity.

Mohamed et al., (2017) tested the Antiviral Potential of Leaf Extracts from Moringa oleifera. The result from this study indicated that antiviral assay of M. oleifera aqueous extract at concentration of 200 µg/ml revealed inhibition percentage of 43.2% and 21.4% for herpes simplex virus type 1 and 2, respectively. These are evidences that moringa oleifera can be used singly or incorporation with viral drugs in the treatment of viral disease.

Potential Use and Future Applications

Moringa oleifera has been broadly used in food and treatment to certain microbial infections and diseases through traditional medicine. Various studies have shown that Crude extracts from Moringa oleifera exhibit antimicrobial activity against various pathogenic bacteria, fungi, viruses and parasites that affect man and his environment. It can be used in medicinal treatments to control the infection of pathogenic microbes. In agriculture, Moringa oleifera can improve the control of phytopathogenic fungi that cause disease and affect the production of economic crops. In marine aquaculture, Moringa oleifera also shows a promising future in the control of infectious diseases. For Future application, it is important to promote the isolation and identification of certain bioactive molecules with potential antimicrobial activity from Moringa oleifera. Also, evaluate the safety and toxicity of antimicrobial agents form Moringa oleifera before implementing the use of these compounds.
The detailed antimicrobial molecular mechanism of compounds to *Moringa oleifera* is of crucial value. In brief, this review provides valuable information on *Moringa oleifera* antimicrobial activity and its potential applications.

**CONCLUSION**

In conclusion, nearly all parts of *Moringa oleifera* (the leaves, bark, root, flower, seed, flowers, Fruits) have been reported with antimicrobial activities against different microorganisms. Antimicrobial reported effects include antibacterial, antifungal, antiviral, antiparasitic and wound healing potentials. Hence the need to isolate bioactive compounds for novel herbal medicine.

**REFERENCE**


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