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Biological Aspects and Its Importance of *Moringa oleifera*

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ABSTRACT

Moringa oleifera is regarded as a significant medicinal plant across the board and is grown in many parts of the world. It is employed in a broad range of medical treatments that attempt to improve the nutritional qualities that are already present in our bodies. This is due to the fact that it has a particularly high nutritive content. Throughout this conversation, we have addressed a broad variety of biological activities, such as those that are anti-inflammatory, antibacterial, antifungal, antipyretic, antispasmodic and many more. In addition, we have shown that it is possible to manufacture a variety of metal nanoparticles by using the extract of different components of Moringa oleifera as the starting material. The main goal of this part of the study was to figure out how important Moringa oleifera is in the field of nano-medicine.

Keywords: *Moringa oleifera*, Nutritional importance, Biological activities, Nanomedicine, Antispasmodic

INTRODUCTION

Moringa oleifera Lam, also known by its synonym M. Pterygospermin Gaertn, is one of the most well-known, widespread and naturalized species in the monogeneric family Moringaceae. The height of the tree may vary anywhere from 5 meters to 10 meters. It flourishes best in the tropical environment of the islands and is abundant close to the sandy beds of rivers and streams [1]. It may be found growing wild as well as being grown across the plains, particularly in hedges and in the yards of houses. It thrives in both the moist tropics and the scorching, arid plains are able to endure even the most depleted soils and are only moderately impacted by drought. It has a pH range of 5.0-9.0 and can survive in a broad variety of rainfall conditions, with its lowest annual rainfall needs estimated at 250 millimeters and its highest at over three thousand millimeters. *Moringa oleifera*, a native of the western and sub-Himalayan regions of India, Pakistan, Asia Minor, Africa and Arabia, is now found in the Philippines, Cambodia, Central America, North and South America and the Caribbean Islands [2]. *Moringa oleifera* is used for its high oil content. *M. oleifera* is known as the "drumstick tree" or the "horse radish tree" in some regions of the globe, while in other areas it is known as the "kelor tree". In the Nile valley, the name of the tree is "Shagara al Rauwaq," which translates to "tree for purifying". You may find this tree there. *M. oleifera*, also referred

to as “Sohanjna” in Pakistan, is planted and farmed all across the nation [3]. In Pakistan, this plant is known by its native name. *Moringa oleifera*, sometimes known as the “natural nutrition of the tropics’’ is a significant food product that has garnered a lot of attention in recent years.

In many nations, including India, Pakistan, the Philippines, Hawaii and many regions of Africa [4], this tree’s leaves, fruit, blossoms and immature pods are consumed as a very nutritious vegetable. It has been found that *Moringa* leaves are a rich source of beta carotene, protein, vitamin C, calcium and potassium. They also act as a good source of natural antioxidants and as a result, they enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolic and carotenoids [5,6]. *Moringa oleifera* leaves have also been reported to be a good source of natural fiber. It is known as the “mother’s closest friend’’ in the Philippines because it can help improve a woman's milk supply and is occasionally prescribed for anaemia [7,8]. This is the origin of the common name.

Because they are high in Ca^{2+}, K^{+}, waxes, alkaloids, quercetin and kaempfero, the flowers of *M. oleifera* are often combined with other meals in Asia. This is done to take advantage of the flowers nutritional profile. Flavonoids are chemicals that have phenolic hydroxyl groups and antioxidant activity; flavonoids include quercetin and kaempferol. Flavonoids have the potential to be used therapeutically. When Kupffer cells are subjected to an insult, quercetin and other flavonoids have been found to have a significant inhibitory effect on the generation of both nitric oxide and tumor necrosis factor [9]. These results come from *in vitro* research. Flavonoids protect the cells from damage produced by X-rays, suppress mutations, limit the advancement of the cell cycle and prostaglandin production and prevent carcinogenesis in experimental animals [10]. It has been shown that almost the whole plant contains a high amount of tocopherol, with levels ranging from 5.7 micrograms per gram (Adult leaves) to 27.8 micrograms per gram (6 month old leaves) of dry mass. Significant differences have been found in the levels of alpha tocopherol, which varied from 95.9 g/g per gram of green seeds to 744.5 g/g per gram of leaves from mature plants [11]. This disparity might most likely be accounted for by differences in the ages of the plants and the components that make up each plant. Tocopherols are the components that make up vitamin E, which is an antioxidant and gamma tocopherol is the most important and prevalent of these tocopherols. This vitamin contributes to the inhibition of chain reactions that lead to the oxidation of polyunsaturated lipids in cellular and subcellular membranes that are caused by the release of free radicals from those membranes. In order to keep the redox balance inside the cell intact, these antioxidant molecules neutralize peroxides before they may damage the cell membranes. If this condition isn't met, it can cause oxidative stress, which can lead to diseases like cancer and atherosclerosis [12].

Because of the substantial levels of vitamins A, B and C, as well as Ca^{2+} and Fe that are included in the leaves, they are used all over the globe as a nutritional supplement. There are also traces of carotenoids, namely beta carotene (401 milligrams per kilogram of dry matter) and xanthins (neoxanthin 219 milligrams per kilogram, violaxanthin 76.5 milligrams per kilogram and zeaxanthin 19.4 milligrams per kilogram). Fresh leaves are often utilized in food preservation practices in India and the Philippines, most likely as a result of the presence of antioxidant compounds [13]. Free radicals can be neutralized by vitamin C, which also has the ability to indirectly replenish vitamin E. Vitamin C has the potential to stop gingival bleeding in addition to its well established involvement in collagen synthesis, which stops gingival bleeding and skin ecchymosis, both of which are signs of scurvy. Vitamin C also reduces gingival bleeding as a result of its ability to stop skin ecchymosis. As a result of this synergism, both of these vitamins have garnered interest as potential agents that can slow the progression of atherosclerosis by lowering levels of Low Density Lipoprotein (LDL) oxidation and as a consequence of this, limiting or even preventing injuries to vascular endothelial cells. This synergism has caused both of these vitamins to garner interest as potential agents that can slow the progression of atherosclerosis [14]. This synergism is the reason why both of these vitamins have garnered this interest.

Moringa oleifera is a resilient tree that has the potential to develop swiftly in a number of different tropical and subtropical environments. Because of the therapeutic and nutritional advantages it provides, it has been used for a very long time. This is due to the fact that it delivers these benefits. Compounds that are extracted from various parts of the tree have been shown to have a wide range of therapeutic properties, including those that are antibacterial, anti-inflammatory, anticancer and hepatoprotective, amongst others. Due to the absence of complete information, there is a gap in our understanding of the factors that contribute to a number of these effects [15]. On the other hand, the potential to develop novel treatments and sustainable bio-products from this renewable and readily accessible resource is considerable, and it is of particular benefit to nations that are currently experiencing economic hardship. This is because the potential to develop these novel treatments and sustainable derivatives comes from this resource. Even though there have been many suggestions for medical and therapeutic uses of goods derived from the *Moringa* tree, the use of proteins extracted from the *Moringa* tree’s seeds in the process of water purification has garnered the

most interest. This is due to the fact that proteins are known to have antimicrobial and antifungal properties. This is in spite of the fact that there have been many suggestions for employing such applications [16]. As has been shown, when applied to water, the powder that is produced by drying and crushing *Moringa oleifera* seeds has antibacterial and flocculants properties. The powder may be acquired by clicking here. Because of this, it is a method for water filtration that is not only inexpensive but also straightforward to use. It has been discovered that a short cationic protein called *Moringa oleifera* Cationic Protein (MOCP), which is found within the *Moringa* seed, is a significant contributor to the seed powder's capacity to inhibit cell growth and settle negative particles out of solution. This protein can be found in the *Moringa* seed. The presence of MOCP in *Moringa* seeds allowed for the completion of this investigation and subsequent discoveries. The seeds of the *Moringa* plant are an excellent source of this particular type of protein. It is envisaged that the ability of MOCP to inhibit the growth of microorganisms would result in the creation of a greater diversity of applications for this protein.

LITERATURE REVIEW

As part of this research, we explored the molecular mechanism that underlies the interaction of this protein with the cell membranes of bacteria as part of the scope of this research. Our goal was to determine whether or not it has the potential to be used as an antibacterial agent. It has been hypothesized that MOCP causes interference with the membranes of bacterial cells, which ultimately results in the membranes being disrupted and the bacterial cells dying as a result. There are two key structural properties that contribute to MOCP's action as an antibacterial agent. Both of these qualities may be found in the molecule. To begin with, it has a whole positive charge, which makes the first interaction with the membranes of microorganisms a great deal less difficult. This is because the membranes are positively charged. Bacterial membranes in general are targeted by MOCP and other cationic antimicrobial peptides [17,18]. This is because bacterial membranes are distinguished from eukaryotic membranes by a high density of anionic lipids by a high density of anionic lipids, whereas eukaryotic membranes do not have this characteristic. This characteristic is absent in the membranes of eukaryotic organisms. In addition to this, MOCP has an amphiphilic helix loop helix motif, which makes it feasible for the protein to be integrated into bacterial membranes. This is because of MOCP's ability to interact with both hydrophobic and hydrophilic environments. MOCP has the capability to selectively target and eradicate a broad range of microorganisms, including waterborne diseases that might potentially be harmful to a person's health [19]. This ability is made possible by the aforementioned characteristics.

Nutritional value of *M. oleifera*

Moringa oleifera leaves contain essential amino acids, including the amino acids that contain sulphur at levels that are higher than those recommended by the Food and Agriculture Organization (FAO) and with patterns that are comparable to those of soybean seeds. *Moringa oleifera* leaves also contain patterns that are comparable to those of soybean seeds. These amino acids can be discovered arranged in patterns that are comparable to those that are found in soybean seeds. The proximate composition of *Moringa oleifera* seeds has been analysed, and the results have shown significant quantities of both lipids and proteins, with just a few small changes [20]. These differences can be attributable to the fact that the seeds were gathered at different times of the year, under varying climatic circumstances and on various kinds of soil. According to Abdulkarim et al., high levels of total proteins were found; it turned out to be superior than significant leguminous seeds in terms of their contribution to human nutrition. Dry seeds of important leguminous seeds typically contain 18%-25% protein, which is nearly double the amount of protein found in cereals [21].

The lipid content of the seed, as reported by Oliveira, was higher than that of other kinds of soybean (149 g/kg-220 g/kg meal) with a value of 412.0 standard deviations or 22.2 grams per kilogram of dry matter. The seeds contain a significant number of saturated fatty acids, the palmitic, stearic, arachidic and benzoic acids rank among the most significant of these fatty acids. *Moringa oleifera* seed contains the highest proportion of oleic acid compared to other types of unsaturated fatty acids, accounting for 67.9%-70.0% of the total [22]. *Moringa oleifera* seed oil has been used as a solidifying agent in margarines and other consumables containing solid or semi-solid fat in order to reduce the requirement for hydrogenation processes. Oleic acid rich plant oils have received a great deal of interest recently due to research showing that a diet rich in trans and saturated fatty acids increases one's risk of cardiovascular disease [23]. Vegetable oils have gotten a lot of attention lately. *Moringa oleifera* seed oil is employed in a range of industrial applications because it is resistant to oxidative rancidification. Cosmetics, equipment lubricants, cooking oil and lamp fuel are just a few of the many uses for kerosene. The excellent ability of *Moringa oleifera* seed oil to

retain fragrances makes it highly prized in the perfume business [24]. Lysine, threonine and valine are all contained in lesser proportions in seed meal than is recommended for children aged 2 years to 5 years old, but the rest of the essential amino acids are present in significant concentrations. Methionine and cysteine levels (43.6 g/kg protein) are equivalent to those seen in human and cow milk and chicken eggs [25].

It is commonly linked to alkaloids, saponins, cyanogenic glucosides and glucosinolates, and it has also been argued that this taste would not restrict the use of this material in animal diets [26]. The seeds have a bitter taste. Both *M. oleifera* and *M. stenopetala* have a significant amount of genetic variation within their populations. According to the available research, there are a great number of distinct types and the flavours of their kernels range from highly sweet to quite bitter. People may eat the seeds of some kinds after roasting and the flavour is similar to that of peanuts. It is possible that the amount of protein available for animal absorption in the seeds (62%-69%) is greater than that found in wheat bran [27]. Countries in Africa and South Asia have historically made use of an extract of the seeds in water to clean their drinking water. Additionally, it has been used as a natural coagulant due to the fact that it contains significant concentrations of active cationic proteins with a molecular mass ranging from 6 kDa to 16 kDa and has extremely alkaline isoelectric points [28,29]. When it came to samples with a high turbidity, the effectiveness of the coagulation was comparable to that of alum. According to the findings of many studies, this water extract is not very harmful. Its LD_{50} value is just 512.8 mg/kg of body weight. When compared to the toxicological criteria for humans, this LD_{50} value is only regarded as mildly hazardous to human health. Furthermore, it is well known that treating the seeds for one to two hours has the potential to eliminate 99.9% of the bacteria floating in water [30,31]. It has just been introduced in the north-eastern region of Brazil with doses ranging from 30 mg/L to 200 mg/L of the seed powder suspension. It has been encouraged in residential areas because of its appeal as a fence and the shade it provides. Considering all of this, it's no wonder that seeds are now being used as coagulants all over the world. The crude extract of *Moringa oleifera* seeds could be used to clean water instead, especially in underdeveloped nations to save money and enhance water supplies in rural areas, even though this has not been done on a wide scale yet [32].

Biological properties of *Moringa oleifera*

Cardiac and circulatory stimulant activity: In addition to the bradycardia impact of *Moringa oleifera* leaves, which was researched in the past, it has been revealed that all components of *Moringa oleifera* have some degree of cardiac and circulatory stimulating action (Figure 1). *Moringa* includes the alkaloid moringinine in its root bark and this alkaloid has been shown to stimulate heart activity by acting on the sympathetic nervous system [33]. The avoidance of hyperlipidemia may potentially lead to the outcomes that have been discussed above. It has been shown that a lack of iron in male wistar rats causes hyperlipidemia and that *Moringa oleifera* may prevent this condition. The effects of *Moringa oleifera* leaf extract on cholesterol, triglycerides, blood sugar, heart weight and body weight in adrenaline induced rats were studied in comparison to atenolol, a selective 1 receptor antagonist drug used to treat cardiovascular diseases. The results showed that *Moringa oleifera* leaf extract significantly altered cardiovascular parameters [34]. The study was performed on the serum cholesterol level and serum triglycerides. According to the findings of this research, the leaf extract of *Moringa oleifera* was hypolipidimic, meaning that it caused a reduction in the animal's body weight, heart weight, serum triglyceride level and serum cholesterol level. In addition to the research that was discussed above, a further study that used simvastatin as a control subject investigated the anti-atherosclerotic and hypolipidimic effects of the leaves of the *Moringa oleifera* plant. *Moringa oleifera* has also been shown to have cardio protective properties in male Wistar albino rats that were given Isoproterenol (ISP) to induce myocardial infarction. It has been observed that therapy with *Moringa oleifera* has a beneficial effect on the biochemical and enzymatic characteristics of many different enzymes, superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase and creatine kinase-MB are a few examples. It also protects against histological damage and ultra-structural changes that could have been caused by ISP induced myocardial infarction.

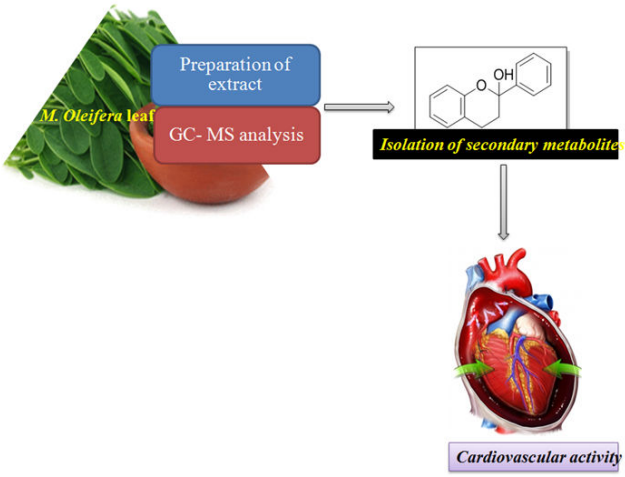

Figure 1 Cardiac activity of *M. oleifera.*

Anti-fertility activity of *Moringa oleifera*

Furthermore, the *Moringa oleifera* plant contains antifertility properties. The antifertility impact seen in rats following administration of an aqueous extract obtained from the root and bark of *Moringa oleifera* also caused fetal resorption at a late stage in pregnancy. An aqueous extract of *Moringa oleifera* roots was also studied for its estrogenic, anti-estrogenic, progestational and anti-progestational activities. Because of its action on the infertility preventing function, this extract generates a variety of negative effects. *Moringa oleifera* leaf extracts were shown to be 100% abortive when dosages of 175 mg/kg of starting dry material were utilized in another study that explored the anti-reproductive ability of plants commonly used in folk medicine [35].

Anti-inflammatory activity of *Moringa oleifera*

There is significant anti-inflammatory action in the components of the *Moringa oleifera* plant. For example, an extract of the roots has a considerable anti-inflammatory effect in rat paw oedema that was caused by carrageenan (Figure 2). A dose dependent inhibition of carrageenan induced rat paw oedema is seen in response to the oral administration of the crude methanol extract of the root. Additionally, an anti-inflammatory effect was shown in guinea pigs when an ovalbumin induced airway inflammation was treated with an extract of the seeds of *Moringa oleifera* treated with n-butanol [36]. Because of the powerful anti-inflammatory action of the bioactive chemicals found in *Moringa oleifera*, it may be feasible to alleviate the symptoms of inflammatory disorders that have been around for a long time [37]. It is possible to hypothesize, given the powerful anti-inflammatory action of the *Moringa oleifera* plant, that this plant has a significant impact on illnesses related to inflammation and the symptoms that come from such disorders. This herb has been shown to have good benefits for asthma as well as discomfort and other symptoms that are the direct outcome of asthma [38].

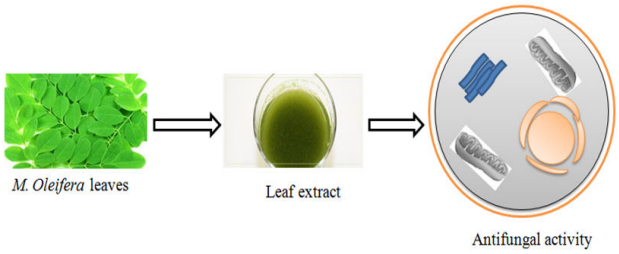

Figure 2 Antifungal activity of *M. oleifera.*

Antipyretic activity of *Moringa oleifera*

It is possible to postulate that the antipyretic activity of *Moringa*'s bioactive components is responsible for *Moringa oleifera* anti-inflammatory impact. Ethanol, petroleum ether, solvent ether and ethyl acetate extracts of MO seeds were subjected to yeast induced hyperpyrexia in order to determine the degree to which they had antipyretic activity. During the course of the trial, the placebo of choice was paracetamol. It shouldn't come as a surprise that extracts of seeds made with ethanol and ethyl acetate exhibited strong antipyretic efficacy in rats [39].

Diuretic activity of *Moringa oleifera*

Due to the fact that this plant has elements that reduce both cholesterol levels and blood pressure, it is very effective in the treatment of cardiovascular disorders. This plant's leaves and the extracts of its leaves have been shown to have a beneficial impact on blood pressure [40]. *Moringa oleifera* leaves have been used to extract a wide variety of chemicals, including glycosides and thiocarbamate glycosides, amongst others. These were essentially accountable for the impact, which was a reduction in blood pressure [41]. All of these compounds have nitrile groups and accelerated glycosides as their functional groups and you won't find either of them in nature very often. Four bioactive compounds, including niazinin A, niazinin B, niazimicin and niazinin A+B, were discovered by Gilani et al. Rats with high blood pressure had their blood pressure lowered by these compounds. This effect was likely caused by a calcium antagonist action.

Antitumor activity of *Moringa oleifera*

In 1997, Makonnen et al. proposed that the leaves of the *Moringa oleifera* plant had a high prospective capability for inhibiting the growth of tumors [42]. An *in vitro* assay was used to investigate the antitumor activity of a *Moringa oleifera* extract as well as several bioactive compounds isolated from *Moringa*, including O-Ethyl-4-(-L-rhamnosyloxy) benzyl carbamate, 4(-L-rhamnosyloxy) benzyl isothiocyanate, niazimicin and 3-O-(6′-O-oleoyl). All of the extracted components and methanolic extracts of *Moringa oleifera* leaf demonstrated strong inhibitory effects on Epstein-Barr virus early antigen. *Moringa oleifera* is a tree that is native to Africa. Niazimicin, which was first discovered in the leaves of the *Moringa oleifera* plant, has been shown to be an effective chemo preventive agent in studies of chemical carcinogenesis [43]. It was proven to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papilloma genesis in mice. This was discovered by Bharali et al., who also assessed the anticancer efficacy using *Moringa oleifera* seed extracts. When a seed ointment was used as an antibiotic on mice with *Staphylococcus aureus* caused pyodermia, the results were similar to those of neomycin [44].

Antispasmodic activity of *Moringa oleifera*

Both the roots and the leaves of *Moringa oleifera* have been found to have antispasmodic properties [45]. Significant pharmacological study has been conducted on the antispasmodic activities of *Moringa oleifera* leaf ethanolic extract and it is conceivable that these effects are generated by calcium channel blockage. *Moringa oleifera* leaf ethanol extract was tested for antispasmodic action in the presence of 4-[-(L-rhamnosyloxy) benzyl]-o-methyl thiocarbamate (Trans), which is the basis for its traditional usage in the treatment of diarrhoea [46]. Furthermore, the spasmolytic activity of various components provides pharmacological support for the plant's historic usage in the treatment of gastrointestinal motility disorders.

Anti-ulcer and hepatoprotective activities

In vivo anti-ulcerogenic and hepatoprotective properties of the methanol extract of *Moringa oleifera* leaf were reported by Pal, et al. [47]. This research was conducted on rats. They have discovered that the methanol extract has extremely high levels of an antiulcer agent, which indicates that the quantity of this agent is present in very high quantities in the extract (Figure 3). They have also conducted research on the same activity using an aqueous extract of the leaf and found that it has strong antiulcer and hepatoprotective potential. It has also been observed that the roots of *Moringa oleifera* and an alcoholic extract of the flower of *Moringa oleifera* have a hepatoprotective effect [48]. This could be because of the flavonoid quercetin, which is well-known for its ability to protect the liver.

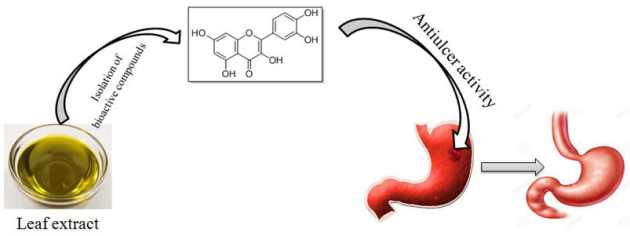

Figure 3 Antiulcer activity of *M. oleifera.*

Antioxidant activity of *Moringa oleifera*

Several fractions of *Moringa oleifera* leaves were tested *in vitro* and *in vivo* to examine their potential antioxidant properties. The antioxidant activity of an aqueous extract of *Moringa oleifera* leaves was tested *in vivo* in normal and diabetic rats. The leaves were ground into a powder and the enzymes that neutralize oxidative free radicals were given 200 mg per kilogram of leaf powder. The activities of superoxide dismutase, catalase and glutathione S-transferase all increased significantly, whereas lipid peroxidation decreased. Because of the plant's antioxidant activity, it was anticipated that the high amounts of phenolic and flavonoid content in *Moringa* extract would protect against oxidative damage in both normal and diabetic individuals.

Antineoplastic activity

Research conducted by Jung in 2014 revealed that an aqueous extract of *Moringa oleifera* leaves possesses significant antineoplastic activity against a lung cancer cell line in addition to other types of cancer cells. The extract has a substantial favorable impact on apoptosis, it has been found to suppress the growth of tumor cells and it has reduced the amount of reactive oxygen species produced within the cells of human lung cancer patients [49]. Also showing strong anti-proliferative activity against malignant human alveolar epithelial cells was the aqueous extract of *Moringa oleifera* leaves. Because it contains phenolic compounds and alkaloids, the extract has antineoplastic action that is very potent. This is owing to the fact that the extract contains these components.

Antidiabetic activity

In 2014, Yassa and Tohamy evaluated the effects of a methanol extract of *Moringa oleifera* leaves on the blood sugar levels of streptozotocin induced diabetic rats. Their research was published in the journal diabetes research and clinical practice. They found that the extract had an antidiabetic effect. They found that treatment with *Moringa oleifera* resulted in a significant reduction in fasting plasma glucose (380% points to 145% points), an increase in reduced glutathione (22% points to 73% points) and a reduction in malondialdehyde (385% points to 186% points) when compared with control levels. The administration of an extract from the leaves of *Moringa oleifera* was successful in reversing the damage caused to islet cells. The rats were given a meal high in fat along with or without a methanol extract of *Moringa oleifera* at daily dosages of 150 mg/kg, 300 mg/kg and 600 mg/kg of body weight for the duration of one month. The higher the daily dosage, the better the results. The study lasted for both conditions. They found that the dosage had an effect on the lowering of lipids in the serum. The highest dose reduced total cholesterol by 37.5%, LDL cholesterol by 61.4%, VLDL cholesterol by 23.5% and total triglycerides by 18.7% [50].

Antibacterial and antifungal activities

Moringa oleifera roots have been shown to have antibacterial action and have been hypothesized to have a high concentration of antimicrobial compounds, according to Rao [51]. Pterygospermin, which was discovered from the *Moringa* pterygospermin, has substantial anti-fungicidal activities in addition to high antibacterial activity. The antibacterial and fungicidal properties of *Moringa oleifera* have been shown to be caused by a large number of molecules that are chemically identical to those that were identified from *Moringa oleifera*. The outstanding antibacterial effect that the root extracts display is due, in large part, to the presence of 4-L-rhamnosyloxybenzyl isothiocyanate, which may be found in the extracts. The aglycone of deoxy-niazimicine, also known as N-benzyl, S-ethyl thioformate, was extracted from the chloroform fraction of the ethanol extract of the root bark, as stated in a

study that was conducted and published in 2003 by Nikkon, et al. It was postulated that this molecule was what was responsible for the antibacterial and antifungal actions that were observed (Table 1).

Table 1 Biological uses of different parts of *M. oleifera*.

Plant part	Uses
Seed	Seed extract having protective effect by decreasing liver lipid peroxides, it is main source for antihypertensive effect.
Leave	Leaves were useful for the decreasing the headache, we can use for piles, fever, throat infection, bronchitis, eye and ear infections; leaf juice is useful for the control glucose levels, applied to reduce glandular swelling.
Flower	Flowers had high medicinal value such as stimulant, aphrodisiac, abortifacient, cholagogue; used to cure inflammations, antimicrobial, antiulcer, muscle diseases, hysteria, tumors and enlargement of the spleen; lower the serum cholesterol, phospholipid, triglyceride, cholesterol to phospholipid ratio and atherogenic index; decrease lipid profile of liver, heart and aorta in hypercholesterolemia rabbits and increased the excretion of faucal cholesterol.
Root	Antilithic, rubefacient, vesicant, carminative, antifertility, anti-inflammatory, stimulant in paralytic afflictions; act as a cardiac/circulatory tonic, used as a laxative, abortifacient, treating rheumatism, inflammations, articular pains, lower back or kidney pain and constipation.
Stem	Antitumor, antiulcer, antidiabetic activities. The juice from the root bark is put into ears to relieve earaches and also placed in a tooth cavity as a pain killer and has anti-tubercular activity.

DISCUSSION

Moringa species in nano-medicine

Antimicrobial activity: Green production of ZnO nanoparticles from *Moringa oleifera* leaf and their antibacterial properties were reported by Elumali [52]. They used the aqueous extract of *Moringa oleifera* to synthesize the ZnO nanoparticles and they validated the production of the nanoparticles using UV, XRD, SEM and TEM studies. The disc diffusion approach was used in order to test the produced nanoparticles for their *in vitro* antibacterial properties. This following approach is utilized for the determination of the nanoparticle's antibacterial activity. A total of 20 milliliters of sterile Muller Hinton agar and 20 milliliters of Sabourdad dextrose agar were used to make the petri plates. After swabbing the usual inoculums using bacterial suspension and yeast suspension onto the top of the solidified medium and allowing them to dry for ten minutes, the inoculums were ready for use. The experiments were carried out using 20 on each disc and three sets of duplicates. After placing the loaded discs on the surface of the medium, it was then put into an incubator at room temperature for half an hour. Negative control was DMSO, while positive control was methicillin for *S. aureus*, ciprofloxacin (10 lg/disc) for bacteria and amphotericin-B (100 units/discs) for *Candida*. DMSO was also used as a negative control (Figure 4). After that, each of the plates was put into an incubator for 24 hours at 37°C for bacteria and 28°C-35°C for *Candida*, respectively. When measuring the light zone of growth inhibition on the agar surface around the discs, the degree of sensitivity of the antimicrobial activity was figured out by using millimeters as the unit of measurement.

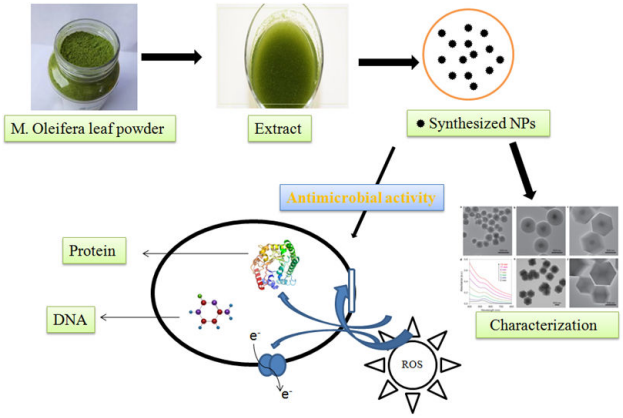

Figure 4 Antimicrobial activity of nanoparticles synthesized from *M. oleifera*.

The bio reduction of silver nanoparticles by employing an aqueous extract of *Moringa oleifera* leaves was reported by Prasad, as well as the antibacterial properties of silver nanoparticles that were generated. They employed the agar well diffusion technique to determine the antibacterial activity of the artificially produced silver nanoparticles [53]. In petri plates that had been sanitized, about 20 mL of molten and then cooled medium (NA/SDA) was added. The plates were kept at room temperature for one day in order to check for contamination and the results of this test were recorded. The test organisms were given 24 hours to develop in the broth of their choice. A broth culture of about 100 mL of each test organism was used to create the lawns and agar wells with a diameter of 5 mm were formed with the use of a stainless steel corn borer that had been sanitized. At a temperature of 37°C, the plates that contained the test organism and the Ag nanoparticles were kept in the incubator for 24 hours to 48 hours. The plates were investigated to see whether there was any evidence of inhibition zones, which had the appearance of a clean region around the wells. The diameter of the zones of inhibition was measured, and the mean value for each organism was written down.

Anti-cancer activity: Anand published a study that described the production of gold nanoparticles from *Moringa oleifera* flowers and the anticancer activity of those particles [56]. The nanoparticles that were generated were characterized by the use of ultraviolet light analysis, X-ray powder diffraction analysis; transmission electron microscopy analysis, scanning transmission electron microscopy analysis and fourier transform infrared spectroscopy analysis. Following the completion of the conformation of the production of gold nanoparticles, the researchers examined the anticancer activity. At two different dilutions, such as 1:100, 1:50, 1:25, 1:10, and 1:3, the gold nanoparticles were considerably cytotoxic to A549 cells, with viabilities of 140%, 139%, 71%, 49% and 12%, respectively. This was the case at all of these concentrations. They have employed various cell viabilities, such as 100%, 100%, 101.1%, 106.1% and 97.1%, respectively and they have not found any evidence of cytotoxicity in normal, healthy PLs that have been treated with AuNPs. Based on these findings, it seemed as if the AuNPs could contain anti-cancer and anti-proliferative capabilities. Plant extracts often have a lot of minerals and phyto compounds, both of which help the extract work against high blood sugar.

Vasanth et al. created silver nanoparticles using the bark extract of *Moringa oleifera* and they employed the generated nanoparticles to assess whether or not they have anticancer action. Various methods of examination, such as UV, XED, SEM and TEM, have been used in order to characterize the silver nanoparticles that have been manufactured. Silver nanoparticles were used in an anticancer investigation conducted using human cervical carcinoma (HeLa) cells, and the results revealed that the nanoparticles had strong anticancer activity. When Li and his colleagues used manufactured AgNPs to test their cytotoxic and genotoxic effects on primary Syrian hamster embryo cells, they discovered that the AgNPs had an impact on the cell cycle, namely that they inhibited cell replication. This was one of the findings. The purpose of these experiments was to determine the possible role that oxidative stress may play as a mechanism for AgNPs induced apoptosis that occurs through the mitochondrial route. When put together, these data give *in vitro* references for the anticancer activity of the produced AgNPs, which is needed for colloidal medicines to work well as anticancer agents.

CONCLUSION

In this present review we have discussed the different biological activities of *Moringa oleifera* based on the literature and research work. All parts of this plant having an excellent medicinal values and high nutritive content. *Moringa oleifera* is using effectively in nano-medicine field.

REFERENCES

[1] Morton JF. The horseradish tree, *Moringa pterygospermin* (Moringaceae)-A boon to arid lands. *Economic Botany*, Vol. 45, No. 3, 1991, pp. 318-333.

[2] Palada MC and Chang LC. Suggested cultural practices for Moringa. *International Cooperators' Guide AVRDC*, 2003, pp. 03-545.

[3] Abdulla M, Gruber P. Role of diet modification in cancer prevention. *Biofactors*, Vol. 12, No. 1-4, 2000, pp. 45-51.

[4] Abdulkarim SM, et al. Some physico-chemical properties of *Moringa oleifera s*eed oil extracted using solvent and aqueous enzymatic methods. *Food Chemistry*, Vol. 93, No. 2, 2005, pp. 253-263.

[5] Anwar F, Ashraf M and Bhanger MI. Interprovenance variation in the composition of *Moringa oleifera* oil seeds from Pakistan. *Journal of the American Oil Chemist's Society*, Vol. 82, No. 1, 2005, pp. 45-51.

[6] Anwar F and Bhanger MI. Analytical characterization of *Moringa oleifera* seed oil grown in temperate regions of Pakistan. *Journal of Agricultural and Food Chemistry*, Vol. 51, No. 22, 2003, pp. 6558-6563.

[7] Chuang PH, et al. Anti-fungal activity of crude extracts and essential oil of *Moringa oleifera* Lam. *Bioresource Technology*, Vol. 98, No. 1, 2007, pp. 232-236.

[8] Moyo B, et al. Polyphenolic content and antioxidant properties of *Moringa oleifera* leaf extracts and enzymatic activity of liver from goats supplemented with *M. oleifera* leaves/sunflower seed cake. *Meat Science*, Vol. 91, No. 4, 2012, pp. 441-447.

[9] Jabeen R, et al. Expression profiling of bioactive genes from *Moringa oleifera*. *Applied Biochemistry and Biotechnology*, Vol. 174, No. 2, 2014, pp. 657-666.

[10] Dillard CJ and German JB. Phytochemicals: Nutraceuticals and human health. *Journal of the Science of Food and Agricultural*, Vol. 80, No. 12, 2000, pp. 1744-1756.

[11] Foidl N, Makkar HP and Becker K. The potential of *Moringa oleifera* for agricultural and industrial uses. 2001.

[12] Ghebremichael KA, et al. A simple purification and activity assay of the coagulant protein from *Moringa oleifera* seed. *Water Research*, Vol. 39, No. 11, 2005, pp. 2338-2344.

[13] Kawada N, et al. Effect of antioxidants, resveratrol, quercetin and N-acetylcysteine, on the functions of cultured rat hepatic stellate cells and Kupffer cells. *Hepatology*, Vol. 27, No. 5, 1998, pp. 1265-1274.

[14] Lürling M and Beekman W. Anti-cyanobacterial activity of *Moringa oleifera* seeds. *Journal of Applied Phycology*, Vol. 22, No. 4, 2010, pp. 503-510.

[15] Ndabigengesere A, Narasiah KS and Talbot BG. Active agents and mechanism of coagulation of turbid waters using *Moringa oleifera*. *Water Research*, Vol. 29, No. 2, 1995, pp. 703-710.

[16] Okuda T, et al. Improvement of extraction method of coagulation active components from *Moringa oleifera* seeds. *Water Research*, Vol. 33, No. 15, 1999, pp. 3373-3378.

[17] Oliveira JT, et al. Compositional and nutritional attributes of seeds from the multiple purpose tree *Moringa oleifera* Lamarck. *Journal of the Science of Food and Agriculture*, Vol. 79, No. 6, 1999, pp. 815-820.

[18] Santos AF, et al. Detection of water soluble lectin and antioxidant component from *Moringa oleifera* seeds. *Water Research*, Vol. 39, No. 6, 2005, pp. 975-980.

[19] Shebek K, et al. The flocculating cationic polypeptide from *Moringa oleifera* seeds damages bacterial cell membranes by causing membrane fusion. *Langmuir*, Vol. 31, No. 15, 2015, pp. 4496-4502.

[20] Siddhuraju P and Becker K. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro climatic origins of drumstick tree (*Moringa oleifera* Lam.). *Journal of Agricultural and Food Chemistry*, Vol. 51, No. 8, 2003, pp. 2144-2155.

[21] Singh U and Singh B. Tropical grain legumes as important human food. *Economic Botany*, Vol. 46, No. 3, 1992, pp. 310-312.

[22] Siguel EN and Lerman RH. Trans fatty acid patterns in patients with angiographically documented coronary artery disease. *American Journal of Cardiology*, Vol. 71, No. 11, 1993, pp. 916-920.

[23] Soliva CR, et al. Feeding value of whole and extracted *Moringa oleifera* leaves for ruminants and their effects on ruminal fermentation *in vitro*. *Animal Feed Science and Technology*, Vol. 118, No. 1-2, 2005, pp. 47-62.

[24] Thompson LU. Potential health benefits and problems associated with antinutrients with foods. *Food Research International*, Vol. 26, No. 2, 1993, pp. 131-149.

[25] Rao AV, Devi PU and Kamath R. *In vivo* radio protective effect of *Moringa oleifera* leaves. *Indian Journal Experimental Biology*, Vol. 39, No. 9, 2001, pp. 858-863.

[26] Vasconcelos IM, et al. Nutritional study of two Brazilian soybean (Glycine max) cultivars differing in the contents of antinutritional and toxic proteins. *Journal of Nutritional Biochemistry*, Vol. 12, No. 1, 2001, pp. 55-62.

[27] Pandas S. Butanolic fraction of *Moringa oleifera* Lam. (Moringaceae) attenuates isoprotrenol induced cardiac necrosis and oxidative stress in rats: An EPR study. *Excli Journal*, Vol. 14, 2015, pp. 64-74.

[28] Ara N, Rashid M and Amran MS. Comparison of *Moringa oleifera* leaves extract with atenolol on serum triglyceride, serum cholesterol, blood glucose, heart weight, body weight in adrenaline induced rats. *Saudi Journal of Biological Sciences*, Vol. 15, No. 2, 2008, pp. 253-258.

[29] Nath D, et al. Commonly used India abortifacient plants with special reference to their teratologic effects in rats. *Journal of Ethnopharmacology*, Vol. 36, No. 2, 1992, pp. 147-154.

[30] Mahajan SG, et al. Inhibitory effect of n-butanol fraction of *Moringa oleifera L*am. seeds on ovalbumin induced airway inflammation in a Guinea pig model of asthma. *International Journal of Toxicology*, Vol. 28, No. 6, 2009, pp. 519-527.

[31] Muangnoi C, et al. *Moringa oleifera* pod inhibits inflammatory mediator production by lipopolysaccharide stimulated RAW 264.7 murine macrophage cell lines. *Inflammation*, Vol. 35, No. 2, 2011, pp. 445-55.

[32] Adedapo AA, Falayi OO and Oyagbemi AA. Evaluation of the analgesic, anti-inflammatory, anti-oxidant, phytochemical and toxicological properties of the methanolic leaf extract of commercially processed *Moringa oleifera* in some laboratory animals. *Journal of Basic and Clinical Physiology and Pharmacology*, Vol. 26, No. 5, 2015, pp. 491-499.

[33] Dahot MU. Vitamin contents of flowers and seeds of *Moringa oleifera*. *Pakistan Journal of Biochemistry*, Vol. 21, 1988, pp. 1-24.

[34] Faizi S, et al. Isolation and structure elucidation of new nitrile and mustard oil glycosides from *Moringa oleifera* and their effect on blood pressure. *Journal of Natural Products*, Vol. 57, No. 9, 1994, pp. 1256-1261.

[35] Fahey JW, Zalcmann AT and Talalay P. The chemical diversity and distribution of glucosinolates and isothiocyanate among plants. *Phytochemistry*, Vol. 56, No. 1, 2001, pp. 5-51.

[36] Gilani AH, et al. Pharmacological studies on hypotensive and spasmodic activities of pure compounds from *Moringa oleifera*. *Phytotherapy Research*, Vol. 8, No. 2, 1994, pp. 87-91.

[37] Makonnen E, Hunde A and Damecha G. Hypoglycaemic effect of *Moringa stenopetala* aqueous extract in rabbits. *Phytotherapy Research*, Vol. 11, No. 2, 1997, pp. 147-148.

[38] Guevara AP, et al. An antitumor promoter from *Moringa oleifera* Lam. *Mutation Research*, Vol. 440, No. 2, 1999, pp. 181-188.

[39] Bharali R, Tabassum J and Azad MR. Chemo modulatory effect of *Moringa oleifera*, Lam, on hepatic carcinogen metabolizing enzymes, anti-oxidant parameters and skin papillomagenesis in mice. *Asian Pacific Journal of Cancer Prevention*, Vol. 4, No. 2, 2003, pp. 131-139.

[40] Caceres A and Lopez S. Pharmacologic properties of *Moringa oleifera.* 3: Effect of seed extracts in the treatment of experimental pyodermia. *Fitoterapia*, Vol. 62, 1991, pp. 449-450.

[41] Caceres A, et al. Pharmacological properties of *Moringa oleifera.* 1: Preliminary screening for antimicrobial activity. *Journal of Ethnopharmacology*, Vol. 33, No. 3, 1991, pp. 213-216.

[42] Dangi SY, Jolly CI and Narayanan S. Antihypertensive activity of the total alkaloids from the leaves of *Moringa oleifera*. *Pharmaceutical Biology*, 40, No. 2, 2002, pp. 144-148.

[43] Pal SK, Mukherjee PK and Saha BP. Studies on the antiulcer activity of *Moringa oleifera* leaf extract on gastric ulcer models in rats. *Phytotherapy Research*, Vol. 9, No. 6, 1995, pp. 463-465.

[44] Ruckmani K, et al. Effect of *Moringa oleifera* Lam on paracetamol induced hepatoxicity. *Indian Journal of Pharmaceutical Sciences*, Vol. 60, No. 1, 1998, pp. 33-35.

[45] Jaiswal D, et al. Role of *Moringa oleifera* in regulation of diabetes induced oxidative stress. *Asian Pacific Journal of Tropical Biomedicine*, Vol. 6, No. 6, 2013, pp. 426-432.

[46] Jung IL. Soluble extract of *Moringa oleifera* leaves with a new anticancer activity. *PLoS One*, Vol. 9, No. 4, 2014, pp. e95492.

[47] Yassa HD and Tohamy AF. Extract of *Moringa oleifera* leaves ameliorates streptozotocin induced diabetes mellitus in adult rats. *Acta Histochemica*, Vol. 116, No. 5, 2014, pp. 844-854.

[48] Rao AV, Devi PU and Kamath R. *In vivo* radio protective effect of *Moringa oleifera* leaves. *Indian Journal Experimental Biology*, Vol. 39, No. 9, 2001, pp. 858-863.

[49] Nikkon F, et al. *In vitro* antimicrobial activity of the compound isolated from chloroform extract of *Moringa oleifera* Lam. *Pakistan Journal of Biological Sciences*, Vol. 6, No. 22, 2003, pp. 1888-1890.

[50] Kumar DA, Palanichamy V and Roopan SM. Green synthesis of silver nanoparticles using Alternanthera dentata leaf extract at room temperature and their antimicrobial activity. *Spectrochimica Acta-Part A: Molecular and Biomolecular Spectroscopy*, Vol. 127, 2014, pp. 168-171.

[51] Kumar DA, Palanichamy V and Roopan SM. One step production of AgCl nanoparticles and its antioxidant and photo catalytic activity. *Materials Letters*, Vol. 144, 2015, pp. 62-64.

[52] Thankappan B, et al. Antimicrobial and antibiofilm activity of designed and synthesized antimicrobial peptide, KABT-AMP. *Applied Biochemistry and Biotechnology*, Vol. 170, No. 5, 2013, pp. 1184-1193.

[53] Khan T, et al. Differential effects of thidiazuron on production of anticancer phenolic compounds in callus cultures of Fagonia indica. *Applied Biochemistry and Biotechnology*. Vol. 179, No. 1, 2016, pp. 46-58.