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Pharmacological activity and chemical composition of the *Moringa Oleifera* plant: A comprehensive review

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***Abstract*—** *Moringa Oleifera*, part of the *Moringa*ceae family, has numerous advantages in relation to therapeutic uses and is known for its nutrition value to humans and animals. This fast growing, drought resistant tree with a white/gray, rough (corky) bark and an umbrella shape, is also called a "super food", due to its high content of iron, calcium, potassium and vitamins A, C, E, along with polyphenols and a native base of digestible protein. The bioactive compound content of *Moringa* is primarily made up of phytochemicals including myricetin, phenolic compounds, phenolic acids, flavonoids, isothiocyanates, tannins, saponins, quercetin, zeatin and kaempferol. In addition, each component of the *moringa* plant, i.e., seed, roots, buds, leaves, flowers and bark, have various biological activities which could be utilized to cure many diseases. For example, the biological activity of the *moringa* plant contains anti-inflammatory, antimicrobial, anticancer, antihypertensive, anti-lipidemic, hepatic protective and neurological protective activities. This review will provide an overall view of the mechanism of action, the medicinal applications and the therapeutic quality of compounds that were isolated from *Moringa Oleifera*, while providing new perspectives for the future investigation and advancement.

Key words : *Morenga* ; phytochemical ;super food.

INTRODUCTION

1.1 Definition of planet

The Moringa plant is used worldwide due to its reputation as an important cosmetic ingredient and its nutritional value. In addition to its culinary uses, the leaves and flowers are also consumed. It is considered a favorite among plants for light eating, and its fruit is delicious and used for medicinal purposes. Its oil is also used as food. Its best uses are as an antioxidant and as a cosmetic oil. This herb is known for its beneficial properties in all its parts; its seeds, leaves, and flowers have countless benefits. (1). Most researchers use this planet as a source of nutrition and/or for treating or preventing symptoms associated with various illnesses. However, traditional medicine has been slow to adopt its potential as a dietetic and medicinal source (2). There are 13 different species of *Moringa* found in tropical and subtropical regions of the world (such as Asia and Africa), as show in fig. below ranging from small shrubs to tall trees. Due to its nutritional value, *Moringa* is believed to possess anti-ulcer, anti-diabetic, hepatoprotective, diuretic and cholesterol-lowering properties. In addition, *Moringa* is also being used as a source for skin and hair care products (3).

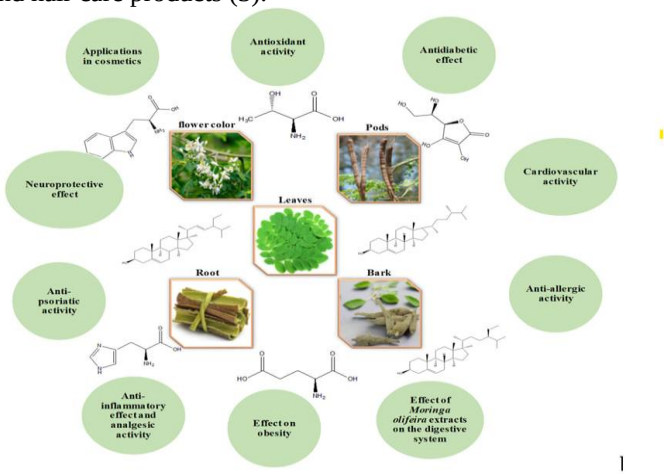

Figure. 1 Constructive properties of the plant M. oleifera on the hominoid organization (3).

Due to their high nutritional values, the leaves of *Moringa Oleifera* are of high demand for their use as a superfood for both humans and animal feed (4). It has been reported that flocks of sheep, goats, cows, and camels will eat the branches of trees that grow at the tops of mountainous terrain and along the valleys. Furthermore, when they do, there are reports of increases in milk production, fertility and endurance, as well as reports of improved health of their young, and an increase in milk fat content in the milk produced by those flocks of livestock. Similarly, it is reported that eating the leaves of these trees improves health and builds the body of the herd members. The meal of *Moringa* has been demonstrated to be beneficial for the health of most animals including livestock, poultry, laboratory animals and other animals used for experimentation (5). It has been noted that many of the chemicals present in *Moringa* are effective against liver-

related diseases. In addition, *Moringa* also provides protection against kidney-related infections. Although it is difficult to obtain the high-quality leaves of this plant, they are available quickly and can be used as a protein-rich feed supplement. This preliminary data aimed to support the findings of many studies which indicate that the leaves of the tree have nutritional values for humans and animals alike. So, the goal of this review is to support the idea that consuming *Moringa* daily will provide the body with sufficient amounts of drive and anti oxidants to helping hand the immune classification and guard beside viral bugs.

1.2 DESCRIPTION OF *MORINGA OLEIFERA* .

Moringa Oleifera, has 13 different kinds of *Moringa*, and also known as Ben oil, Benzoil, Horseradish, Al-Ban, Life tree or Miracle tree, and has the characteristic of having feathery, tripinnate leaves. In addition to that, the tree also bears fragrant, white flowers and hanging, three-sided pods containing winged seeds, which almost all parts of the plant have uses. As well as being spread over many countries on the continents of Asia and Africa. *Moringa Oleifera*, grows relatively large, is a fast-growing tree, reaches an approximate height of 5-10m, has a "semi-open" crown with drooping pods and branches, and has a feathery tripinate shaped foliage, along with thicker, corky, whitish bark. (6) Additionally, the rank (trunk) of the tree, can grow up to a diameter of 40-50cm, while the flowers are approximately 1–1.5cm in length, and 2cm in width, and they are white. Flowering, will typically begin within the first 5-6 months after planting the tree. The pods of the tree are in a droopy shape, are a brown capsule with three sides, are approximately 25–50cm in length, and have a dark brown colour. Semi-spherical seeds, of approximately 0.5-1cm in diameter, are contained within the pod. Each seed has three transparent wings which enable the seed to easily move via wind and/or water (7).

1.3 BIOACTIVE COMPOUNDS

The *Moringa* plant contains a wide variety of bioactive compounds found within its vegetative parts, such as carbohydrate, phenolic compounds, phenolic acids, flavonoids, isothiocyanates, tannins, saponins, oils/fatty acids, and protein/functional peptide, all with large potential for use in a variety of food product formulations (8). The high amounts of bioactive compounds may also account for the pharmacological properties of MO leaves; many studies have demonstrated these properties in both in vitro and in vivo experiments (9). Raw MO leaves contain a healthy amount of Vitamin A, which is important in the vision process, reproductive health, fetal development, cell proliferation and division. Additionally, raw MO leaves contain carotenoids, which have the ability to convert to provitamin A. *Moringa* leaves contain significantly more Vitamin C than an orange, and the Vitamin C acts as an antioxidant protecting the body from the negative effects of free radicals, pollutants and toxins. *Moringa* leaves also contain a significant amount of beta-carotene, Vitamin C, polyphenols, and Vitamin E, similar to that found in nuts (10). The root, bark, gum, leaf, pod (fruit), flower, seed, and seed oil of the MO plant have been reported to exhibit numerous biological activities, including: gastroprotective, anti-diabetic, antihypertensive and anti-inflammatory activities; improved hepatic and renal functions; and the regulation of thyroid hormone levels. *Moringa* leaves Antioxidants also protect against oxidative stress, inflammation, hepatic fibrosis, liver damage, hypercholesterolemia, bacterial activity, cancer, and liver injury (11). The phenolic acids found in the herb have antioxidant, anti-inflammatory, and antifungal properties, which explains its role in cancer prevention. Moringa leaves contain a variety of phenolic acids and flavonoids, classified as polyphenols. The herb releases flavonoids in response to microbial infection. Myricetin, quercetin, and kaempferol are the most abundant flavonoids in the Moringa plant, with concentrations of 1.2, 5, and 7.5 mg/g, respectively. For example, quercetin is known for its effectiveness in reducing blood pressure and thus combating the risk of developing diabetes, as demonstrated in a study conducted on obese mice. The phenolic acids, including hydroxycinnamic acid, which occurs naturally in plants, also have anti-cancer effects. The concentration of gallic acid is 1.034 mg/g, chlorogenic acid (Bulgaria) 0.489 mg/g, and finally, an acid that reached 0.409 mg/g on dry weight (12). Chlorogenic acid is one of the most important components of Moringa oleifera and has a stimulating role in glucose production by inhibiting glucose-6-phosphate dehydrogenase transport in the liver and preventing glycogen buildup in the liver. In addition, it possesses a distinctive characteristic of high saturation through its ability to readily absorb total cholesterol and triglycerides, as demonstrated in tests conducted on diabetic and hyperglycemic laboratory mice (13).

Tannin is a phenol found in a plant's leaves, it dissolves in water and will bind with proteins (gelatin), alkaloids, etc. the amount of tannin found in dried leaves is typically around 13 to 20 grams of tannin per kilogram of dried leaves; however, the amount can be much greater in lyophylized leaves. there is evidence to suggest that tannin possesses anti-cancer, anti-atherosclerotic, anti-inflammatory and anti-hepatotoxic properties (14). *Moringa* leaves are also rich in saponins which are naturally occurring bioactive compounds made from isoprenoids. the level of saponin in the moringa leaves was found to range from 65 grams of saponin per kilogram of dried leaf material to 80 grams of saponin per kilogram of dried leaf material. saponins exhibit antioxidant activity to combat cancer (15).

1.4 ANTIMICROBIAL EFFECTS OF *MORINGA*

The impact of antimicrobial substances from *Moringa Oleifera* seeds has been examined by several researches. Researchers have shown that the number of colonies of bacteria and fungi grown on agar plates decrease when the concentration of the *moringa* seed extract increases. A study found that different extracts of *Moringa* seeds inhibited growth of bacteria such as *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Vibrio cholerae*, *Aspergillus niger*, and

Candida albicans (16). Scientists believe that the active ingredient in *Moringa* seeds which has this antibiotic property is called pterygospermin. It is an organic chemical compound with well-documented antibiotic and fungicidal properties. The mechanism of how pterygospermin exhibits its bacteriostatic effect is through inhibition of uptake of certain amino acids by bacteria. Researchers believe that combinations of these compounds could work together synergistically to restore the efficacy of beta-lactam antibiotics against methicillin resistant Staphylococcus aureus (17). To combat antibiotic resistance in pathogens; researchers have focused their efforts on finding alternative approaches. One approach is to incorporate into food, plant extracts or other safe and effective natural products (18).

1.5 ANTI-INFLAMMATORY EFFECTS OF *MORINGA*

Inflammation is the body's defense mechanism.) Detects cellular injury, irritation or pathogens by the immune system and initiates healing process (19). Chronic inflammation may be causal in the genesis of chronic inflammatory disease(s) and conditions; i.e. heart disease, diabetes, obesity, asthma and colitis (20). Moringa Oleifera can also possibly help with people suffering from inflammatory ailments by reducing inflammation. The bioactive compounds found in moringa practised by phenolic compound, flavonoids and alkaloid. This results in impressive anti-inflammatory potential via the suppression of inflammatory mediators and enzymes. Studies point that moringa may inhibit the expression of inflammatory biomarkers, such as COX-2, NO, TNF-α, IL-6 and IL -1β. Moringa seed extracts contain isothiocyanates which help to decrease edema and inflammatory biomarker production in the body. The Moringa Leaves contain high amounts of Quercitin (an antioxidant) than the grapefruit and okra (5x). It also exerts actions on cancer cells through modulation of the inflammatory process. Baldari 2015) Study of Inflammatory Cytokines from ELISA with group of animals produced good evidence for lower levels of inflammatory cytokines and lowered stress in endoplasmic reticulum with fermented product (21).

1.6 ANTI-OXIDANT EFFECTS OF *MORINGA*

The rich levels of bioactive components within *Moringa* provide for it to have some powerful antioxidant properties. The antioxidant activity of the bioactive components of *Moringa* includes those of phenolic compounds, flavonoids (quercetin) beta carotene, vitamins C and E and protects the body from oxidative damage through neutralizing free radicals. Antioxidants can reduce risk of developing several diseases such as asthma and cardiovascular disease, cancer, and also may exhibit neuroprotective effects to assist with nervous system disorders. One study recently demonstrated that MO leaves were a possible significant source of vitamin C in children to fight off numerous illnesses, such as colds and flu; vitamin A is another component found in MO leaves to act as a shield to defend against eye diseases, skin diseases, heart problems, diarrhea and many others (22).

In addition to these two major vitamins the MO leaves extracts include tannins, saponins, flavonoids, terpenes and glycosides with medicinal properties. Compounds in this category have been used to demonstrate that they function as effective antioxidants and antimicrobial agents against cancer. Phenolic compounds are identified as one of the primary antioxidants due to their role in neutralizing lipid free radicals or protecting hydroperoxides from breaking down into free radicals due to their redox properties, and to break-down peroxides (23).

1.7 HYPO-LIPIDEMIC EFFECTS OF *MORINGA*

The bioactive compounds present in *moringa* leaf are capable of affecting the lipid homeostasis; the phenols and flavonoids that are present regulate the lipid content. The phenols and flavonoids lower plasma cholesterol concentrations by converting them into insoluble complexes and increasing their excretion through feces, thus inhibiting the action of pancreatic cholesterol esterase and reducing and delaying the absorption of cholesterol and combining with bile acids. In turn, the lowered cholesterol has a significant influence on the blood lipid levels, and *moringa* also lessens the negative effects of elevated cholesterol, triglycerides, LDL-cholesterol, malondialdehyde, and ALT and AST as enzyme activities in the serum caused by excessive dietary intake of fats (24). Also, HMG-CoA reductase catalyzes the conversion of cholesterol absorbed from bile produced in the liver during cholesterol biosynthesis, and demonstrates a hypolipidemic effect. Additionally, *Moringa Oleifera* leaves contain β-sitosterol which also has a cholesterol-lowering effect. The saponins in the leaves bind to the cholesterol molecules and to the bile acids and stop the cholesterol from being absorbed. This leads to a decrease in the enterohepatic recirculation of bile acids and an increase in the amount of bile acids excreted through feces. Since there is a reduced output of bile acids, the liver produces fewer bile acids from cholesterol, resulting in a decrease in the plasma cholesterol (25).

1.8 ANTI- DIABETIC EFFECTS OF *MORINGA*

The anti-diabetic activities of Moringa Oleifera leaves, seeds, and their bioactive components have been thoroughly evaluated. Antidiabetic agents (eg, quercetin, chlorogenic acid, isothiocyanates), which can correspond to glycolic homeostasis regulation have shown reduced blood glucose levels and increased insulin sensitivity; that is decreased liver gluconeogenesis and in the case of isothiocyanate observed in leafs 26. For example, phenolic acids and flavonoids have been demonstrated to regulate glucose homeostasis in a way that enhances beta-cell efficacy and function as well as insulin sensitivity in surrounding tissue. Furthermore, because flavonoids and tannins have recently been described as pancreatic and intestinal enzymes inhibitors. The positive impact on carbohydrate metabolism is evidenced by the prevention and attenuation of damage to beta cells structure and function, increased insulin production, promoting glucose synthesis and cellular uptake. Many pre-clinical studies using animal models have indicated that MO leaves show significant

effects in lowering blood glucose, improving lipid profiles and minimizing the damage of organs. The results do, however, require validation by larger scale clinical trials as well as the determination of optimal dosing levels and long term safety (25).

1.9 ANTI-CANCER EFFECTS OF *MORINGA*

Bioactive parts of moringa demonstrate cancer-fighting activity on several cancers such as, but not limited to, breast cancer, prostate cancer and pancreatic ones. Cytotoxic properties of Moringa leaf and seed extracts were displayed due to the ability to inhibit cancer cell growth and thus protecting tissues and cells from oxidative DNA damage associated with both cancerous tissue formation as well as degenerative disease formation. These findings indicate that the extract's antioxidant properties can alter oxidative stress and lead to DNA fragmentation, and its ability to induce apoptosis by accelerating markers of apoptosis suggests that it may lead to cell death in cancer cells. The MO extract also induces apoptosis by inducing ROS generation in mitochondria and MAPK phosphorylation mechanism in human melanoma (28). MO possesses other bioactive constituents like four-(α-l-rhamnosyloxy) benzyl isothiocyanate, niazimicin and β-sitosterol-3-o-β-d-glucopyranoside, etc., which endow MO with anticancer properties. As mentioned above, stem and seed infusions have demonstrated cytotoxic, anticancer and antitumor activities. MO leaf extracts were also used in breast and pancreatic cancer (29).

Multiple experiments on animals revealed that MO leaves possessed anticancer properties in rats with diethyl nitrosamine induced liver carcinomas, as well as azoxymethane induces colon carcinogenesis in mouse models and further showed antidyslipidemic, anti-inflammatory, anticancer and antitumor effects (30). Yes, Qualitative analysis of the leaf extracts showed that they contained phenolic compounds (quercetin and kaempferol), flavonoid and alkaloids in traces. In addition, the study showed that MO has an anti-proliferative effect by causing a loss of cell viability, morphological changes, internucleosomal DNA fragmentation and generation of reactive oxygen species in cells (31). The ROS so increase the caspases inside out cancer cell and induce apoptosis. MO has active glucosinolates against many types of cancers. They can cause apoptosis. MO has demonstrated multiple activity spectrum and may target many proteins, molecules to prevent the growth of cancer cell (32).

1.10 NEURO-PROTECTIVE EFFECTS OF *MORINGA*

Neurodegeneration is a process of death of neurons, with increasing numbers of deaths of the same kind of neuron over time, and with an aging population, this is a growing health issue, resulting in disorders such as dementias and motor disorders. Bioactive compounds from MO protect the antioxidant defense mechanisms in the brain, and reduce inflammation; additionally, they increase the level of neurotransmitters in the brain, which may lead to therapeutic application for neurodegenerative brain disorders. Dementia is a long-term progressive degenerative condition of the brain. Oxidative stress in the form of reactive oxygen species (ROS), can induce apoptosis through mitochondrial dysfunction and lipid, protein and DNA damage. Additionally, it has also been shown that MO can help to increase neurotransmitter activity by significantly potentiating epinephrine and serotonin levels (33). It has previously been demonstrated that oxidative stress is one of the most important causes of neurodegenerative diseases, specifically Alzheimer's disease (AD) and Parkinson's disease (PD). Therefore, antioxidants have become increasingly popular as potential treatments for neurodegenerative diseases. Although numerous studies have attempted to identify potential AD therapies, there are currently no treatments that have been proven to either slow down or halt the progression of the disease. Due to the high costs and associated side effects of prescription anti-dementia medications, natural products containing flavonoids have become very valuable as potential candidate drugs for the prevention and/or treatment of neurodegenerative diseases (34).

Experimental research was conducted on mice that had been induced with Parkinson's disease using MPTP to test whether MO seed extracts containing isothiocyanates could be used as an alternative treatment for a week, and it was found that isothiocyanates were able to regulate the signal transduction involved in oxidative stress and apoptosis and thus may provide an alternative method of preventing PD in a clinical setting. In addition, many research studies have demonstrated that extracts of the leaves of MO can improve both the neurodegeneration of the dentate gyrus of the hippocampus and corneal ammonium region of the retina as well as the ability to visually remember information. Additionally, studies have demonstrated that these extracts are capable of reducing malondialdehyde (MDA) levels as well as acetylcholinesterase (AChE) activity while increasing the levels of superoxide dismutase (SOD) and catalase activity (35).

CONCLUSIONS

Moringa Oleifera, is a miraculous plant that provides numerous benefits through its nutritional value, medicinal and industrial uses. The parts of *Moringa* that are edible and utilized are the leafs, root, bark, and gum; while flowers, seed, and seed oil are used for health purposes. This is a very well-known herb because of its pharmacologic and therapeutic characteristics. *Moringa* contains bio active elements that have been shown to improve your health beyond the basic requirements. Because of its high level of nutritional bioavailability, and medicinal uses, *Moringa* has been found to aid in preventing or alleviating ailments such as: elevated blood pressure, diabetes, obesity, heart disease, cardiac attack, and diseases associated with aging (Parkinson's, Alzheimer's), etc. *Moringa* is also being recognized for its ability to help boost one's immunity. In addition, *Moringa* contains antioxidant-rich bioactive compounds that will help strengthen the body's natural defenses. *Moringa* is quite impressive. More research, including further clinical trials on both lab

animals and humans, need to be completed to confirm this information and to determine the best dosage and preparation of *Moringa* for use in treatment. *Moringa* continues to be considered a "miracle" plant with boundless uses for humanity and can be obtained at a relatively low cost as a superior quality natural gift.

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