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Short Notes

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A Review of Phytochemical and Pharmacological Profile of *Moringa oleifera* Lam.

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ABSTRACT

Providing modern healthcare to rural people in Bangladesh is still a far-reaching goal due to economic constraints. Hence, people mainly depend on the locally available plant materials to cure various health disorders. Plant possesses components which render beneficial properties.(Tanabe *et al* 2002) Therefore, currently attention is being drawn towards exploring plant sources for substances that provide nutritional and pharmaceutical advantages to humans. Green leafy vegetables are a good source of minerals and vitamins.(Rahman *et al* 2010). The use of natural products as medicinal agents presumably predates the earliest recorded history. *Moringa oleifera* is a plant which is used in several traditional medicine systems to cure various diseases. These plant has been known to possess some medicinal resources as Antimicrobial activity, wound healing effect, antidiabetic effect, antioxidant activity, Nephroprotective activity, anti-carcinogenic properties, Anti-inflammatory Activity, immunomodulatory effects, Antifertility Activity, Hepatoprotective Activity, cardio-protective effect, Anti-ulcer Activity, Antipyretic and Analgesic activity, Anthelmintic, Diuretic , Antiurolithiatic, CNS Activity, Local Anaesthetic Activity and other miscellaneous activities. The extracts from *Moringa oleifera* leaf can be a source of natural antimicrobials with potential applications in pharmaceutical industry to control coliform bacteria. .(Rahman *et al* 2010).A wide range of chemical compounds are found in these plants. The pharmacological studies reported in the present review confirm the therapeutic value of *Moringa oleifera*. Thus the use of this plant for human and animal disease therapy and reinforce the importance of the ethno-botanical approach as a potential source of bioactive substances.

Key words: Medicinal plant, *Moringa oleifera*, pharmacology, phytochemistry.

INTRODUCTION

Nature has provided a complete storehouse of remedies to cure ailment of mankind. About 80% of the world's population depends wholly or partially on traditional medicine for its primary health care needs (Kunwar and Adhikari, 2005). According to a survey (WHO, 1993) of World Health Organization (WHO), the practitioners oftraditional system of medicine treat about 80% of patients in India, 85% in Burma and 90% in Bangladesh (Siddiqui, 1993). Herbal medicines, as the major remedy in traditional medical systems (Rahman *et al.*, 2011) have been used in medical practice for thousands of years and have made a great contribution to maintain human health. A majority of the world's population in developing countries still relies on herbal medicines to meet its health needs. The attention paid by health authorities to the use of herbal medicines has increased considerably, both because they are often the only medicine available in less developed areas and because they are becoming a popular alternative medicine in more developed areas (Gurib-Fakim, 2006). The medicinal plants are rich in secondary metabolites (which are potential sources of drugs) and essential oils of therapeutic importance. The important advantages claimed for therapeutic uses of medicinal plants in various ailments are their safety besides being economical, effective and their easy

availability (Atal and Kapoor, 1989; Siddiqui, 1993). *M. oleifera* is rich in compounds containing the simple sugar, rhamnose and a fairly unique group of compounds called glucosinolates and isothiocyanates.(Bennett *et al* 2003.).Sulaiman et al has evaluated of *M. oleifera* aqueous extract for antinociceptive and anti-inflammatory activities in animal models. Mahajan *et al*4 has reported seed extract of *M. oleifera* has effect on toluene diisocyanate-induced immune-mediated inflammatory responses in rats.Almost all the parts of this plant have various effects such as cardiovascular activity, gastrointestinal activity, hematological activity, hepatorenal disorders inhibitory activity.5,6 *M. oleifera* have been extensively studied pharmacologically and it has been found that the ethanol extract and its constituents exhibit antispasmodic, antitumor activity antiulcer and hepatoprotective activities.(Ezeamuzie *et al* 1996, Ali *et al* 2004 and Mahajan *et al* 2007) It *has* also been reported to exhibit other diverse activities antiurolithiatic, antihypertensive, diuretic and cholesterol lowering activities.(Anwar *et al* 2007 and Karadi *et al* 2008).

PLANT PROFILE

Moringa oleifera (synonym: *Moringa pterygosperma*) is the most widely cultivated species of the genus *Moringa*, which is the only genus in the family Moringaceae. English common names include moringa, benzolive tree,(USDA GRIN Taxonomy) and West Indian ben. It is also known as drumstick tree, from the appearance of the long, slender, triangular seed pods, horseradish tree, from the taste of the roots which resembles horseradish, or ben oil tree, from the oil derived from the seeds. The tree itself is rather slender, with drooping branches that grow to approximately 10m in height. In cultivation, it is often cut back annually to 1-2 meters and allowed to regrow so the pods and leaves remain within arm's reach. In developing countries, *Moringa* has potential to improve nutrition, boost food security, foster rural development, and support sustainable landcare.(National Research Council,2006). It may be used as forage for livestock, a micronutrient liquid, a natural anthelmintic and possible adjuvant.(H.P. Makkar *et al.* 2007;S.G Mahajan, *et al* 2007).

In April 2012, Moringa oleifera was presented on Dr. Oz Show as a supplement to improve energy levels and overall wellbeing. Dr. Oz presented *Moringa* as tea bags. The *Moringa* tree is grown mainly in semiarid, tropical, and subtropical areas, corresponding in the United States to USDA hardiness zones 9 and 10. While it grows best in dry, sandy soil, it tolerates poor soil, including coastal areas. It is a fast-growing, drought-resistant tree that is native to the southern foothills of the Himalayas in northwestern India. Cultivation in Hawai'i, for commercial distribution in the United States, is in its early stages. (T Radovich *et al* 2010) India is the largest producer of *Moringa*, with an annual production of 1.1 to 1.3 million tonnes of tender fruits from an area of 380 km². Among the states, Andhra Pradesh leads in both area and production (156.65 km²) followed by Karnataka (102.8 km²) and Tamil Nadu (74.08 km²). In other states, it occupies an area of 46.13 km². Tamil Nadu is the pioneering state insomuch as it has varied genotypes from diversified geographical areas and introductions from Sri Lanka.(J. Rajangam *et al* 2001) Moringa is grown in home gardens and as living fences in Thailand, where it is commonly sold in local markets. In the Philippines, it is commonly grown for its leaves, which are used in soup (Food and Agriculture Organization of the United Nations). Food and Agriculture Organization of the United Nations Moringa is also actively cultivated by the World Vegetable Center in Taiwan, a center for vegetable research with a mission to reduce poverty and malnutrition in developing countries through improved production and consumption of vegetables. It is also widely cultivated in Africa, Cambodia, Nepal, Indonesia, Malaysia, Mexico, Central and South America, and Sri Lanka.

Scientific Classsification:

Kingdom:	Plantae
Unranked:	Angiosperms
Unranked:	Eudicots
Unranked:	Rosids
Order:	Brassicales
Family:	Moringaceae

Genus:	*Moringa*
Species:	***M. oleifera***

Botanical Description:

Latin	*Moringa oleifera*
Sanskrit	Subhanjana
Hindi	Saguna, Sainjna
Bangla	Sainjna
Gujarati	Suragavo
Tamil	Morigkai
Telugu	Mulaga, Munaga
Malayalam	Murinna, Sigru
Punjabi	Sainjna, Soanjna
Unani	Sahajan
Ayurvedic	Akshiva, Haritashaaka,
Arabian	Rawag
French	Moringe à graine ailée, Morungue
Spanish	Ángela, Ben, Moringa
Portuguese	Moringa, Moringueiro
Chinese	La ken
English	Drumstick tree, Horseradish tree, Ben tree

NUTRITIONAL CONTENT

Many parts of the *Moringa* are edible. Regional uses of the *Moringa* as food vary widely, and include:

The immature seed pods, called "drumsticks", popular in Asia and Africa.

- Leaves, particularly in the Cambodia, Philippines, South India and Africa.
- Mature seeds
- Oil pressed from the mature seeds
- Roots

In some regions, the young seed pods are most commonly eaten, while in others, the leaves are the most commonly used part of the plant. The flowers are edible when cooked and are said to taste like mushrooms. The bark, sap, roots, leaves, seeds, oil, and flowers are used in traditional medicine in several countries. In Jamaica, the sap is used for a blue dye.

(www.en.wikipedia.org/wiki/Moringa_oleifera)

***Moringa oleifera* leaf, raw**

Nutritional value per 100 g (3.5 oz) (www.TFLJournal.org)

Energy	64 kcal (270 kJ)
Carbohydrates	8.28 g
Dietary fiber	2.0 g
Fat	1.40 g
Protein	9.40 g
Water	78.66 g
Vitamin A equiv	378 µg (47%)
Thiamine (vit. B_1)	0.257 mg (22%)
Riboflavin (vit. B_2)	0.660 mg (55%)

Pantothenic acid (B_5)	0.125 mg (3%)
Vitamin B_6	1.200 mg (92%)
Folate (vit. B_9)	40 µg (10%)
Vitamin C	51.7 mg (62%)
Calcium	185 mg (19%)
Iron	4.00 mg (31%)
Magnesium	147 mg (41%)
Manganese	0.36 mg (17%)
Phosphorus	112 mg (16%)
Potassium	337 mg (7%)
Sodium	9 mg (1%)
Zinc	0.6 mg (6%)

***Moringa oleifera* Pods, raw**
Nutritional value per 100 g (3.5 oz)(USDA Nutrient Database)

Energy	37 kcal (150 kJ)
Carbohydrates	8.53 g
Dietary fiber	3.2 g
Fat	0.20 g
Protein	2.10 g
Water	88.20 g
Vitamin A equiv	4 µg (1%)
Thiamine (vit. B_1)	0.0530 mg (5%)
Riboflavin (vit. B_2)	0.074 mg (6%)
Niacin (vit. B_3)	0.620 mg (4%)
Pantothenic acid (B_5)	0.794 mg (16%)
Vitamin B_6	0.120 mg (9%)
Folate (vit. B_9)	44 µg (11%)
Vitamin C	141.0 mg (170%)
Calcium	30 mg (3%)
Iron	0.36 mg (3%)
Magnesium	45 mg (13%)
Manganese	0.259 mg (12%)
Phosphorus	50 mg (7%)
Potassium	461 mg (10%)
Sodium	42 mg (3%)
Zinc	0.45 mg (5%)

PHYTOCHEMICAL CONSTITUENT

Phytochemicals are, in the strictest sense of the word, chemicals produced by plants. Commonly, though, the word refers to only those chemicals which may have an impact on health, or on flavor, texture, smell, or color of the plants, but are not required by humans as essential nutrients. An examination of the phytochemicals of Moringa species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates. For example, specific components of

Moringa preparations that have been reported to have hypo-tensive, anticancer, and antibacterial activity include 4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocy-anate **[1],** 4-(α-L-rhamnopyranosyloxy)benzyl isothiocy-anate **[2],** niazimicin **[3]**, pterygospermin **[4],** benzyl isothiocyanate **[5],** and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate **[6].** While these compounds are relatively unique to the Moringa family, it is also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A). These attributes are all discussed extensively by Lowell Fuglie and others, and will be the subject of a future review in this series.(www.TFLJournal.org)

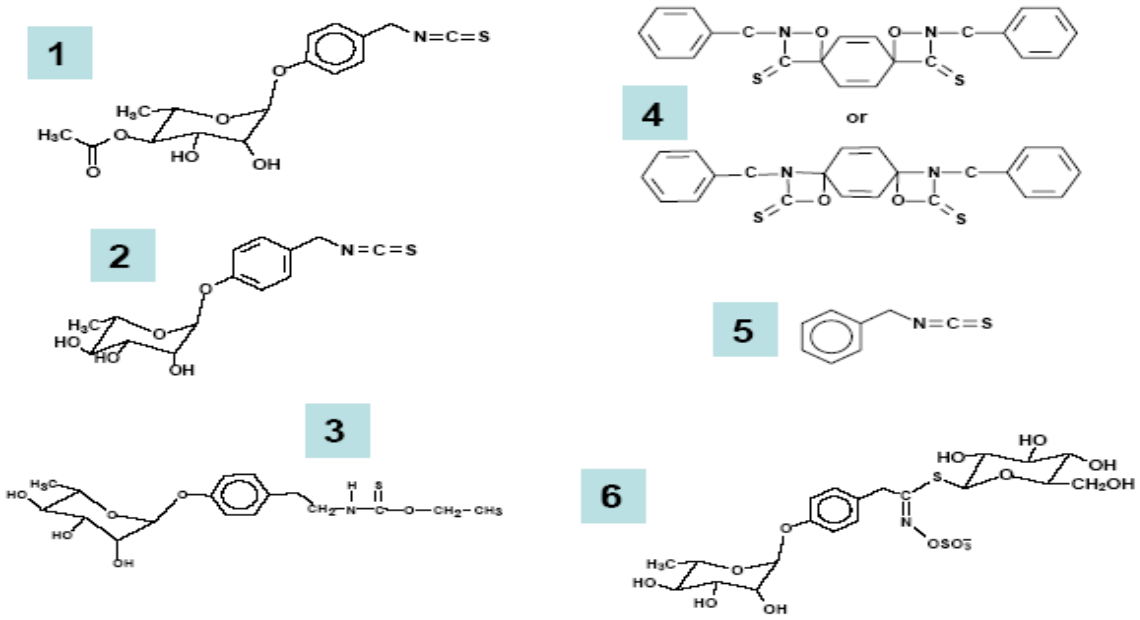

Figure 1. Structures of selected phytochemicals from Moringa spp.: 4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocyanate **[1]**, 4-(-L-rhamnopyranosyloxy)benzyl isothiocyanate **[2]**, niazimicin **[3]**, pterygospermin **[4]**, benzyl isothiocyanate **[5]**, and 4-(α-L-rhamnopyranosyloxy)benzyl glucosinolate **[6]**

ANTIMICROBIAL ACTIVITY

This is clearly the area in which the preponderance of evidence—both classical scientific and extensive anecdotal evidence—is overwhelming. The scientific evidence has now been available for over 50 years, although much of it is completely unknown to western scientists. In the late 1940's and early 1950's a team from the University of Bombay (BR Das), Travancore University (PA Kurup), and the Department of Biochemistry at the Indian Institute of Science in Bangalore (PLN Rao), identified a compound they called pterygospermin a compound which they reported readily dissociated into two molecules of benzyl isothiocyanate. Benzyl isothiocyanate was already understood at that time to have antimicrobial properties. This group not only identified pterygospermin, but performed extensive and elegant characterization of its mode of antimicrobial action in the mid 1950's. (They identified the tree from which they isolated this substance as "*Moringa pterygosperma,"* now regarded as an archaic designation for "*M. oleifera."*) Although others were to show that pterygospermin and extracts of the Moringa plants from which it was isolated were antibacterial against a variety of microbes, the identity of pterygospermin has since been challenged as an artifact of isolation or structural determination.

Subsequent elegant and very thorough work, published in 1964 as a PhD thesis by Bennie Badgett (a student of the well known chemist Martin Ettlinger), identified a number of glyosylated derivatives of benzyl isothiocyanate (e.g. compounds containing the 6-carbon simple sugar, rhamnose). The identity of these compounds was not available in the refereed scientific literature until "re-discovered" 15 years later by Kjaer and co-workers. Seminal reports on the antibiotic activity of the primary rhamnosylated compound then followed, from U Eilert and colleagues in Braunschweig, Germany. They re-isolated and confirmed the identity of

4-(a-L-rhamnopyranosyloxy)benzyl glucosinolate and its cognate isothiocyanate and verified the activity of the latter compound against a wide range of bacteria and fungi.

Extensive field reports and ecological studies forming part of a rich traditional medicine history, claim efficacy of leaf, seed, root, bark, and flowers against a variety of dermal and internal infections. Unfortunately, many of the reports of antibiotic efficacy in humans are not supported by placebo controlled, randomized clinical trials. Again, in keeping with Western medical prejudices, practitioners may not be expected to embrace Moringa for its antibiotic properties. In this case, however, the *in-vitro* (bacterial cultures) and observational studies provide a very plausible mechanistic underpinning for the plethora of efficacy claims that have accumulated over the years.

The organic extracts of hexane, chloroform, ethyl acetate and methanol extracts of *Moringa oleifera* leaf exhibited a remarkable antibacterial effect against all the tested bacterial pathogens. The zones of inhibition against all the tested bacterial pathogens were found in the range of 8.0 to 23.2 mm, along with their respective minimum inhibitory concentration (MIC) values ranging from 62.5-1000 ìg/mL. The results obtained in this study suggest that the extracts from *Moringa oleifera* leaf can be a source of natural antimicrobials with potential applications in pharmaceutical industry to control coliform bacteria.(Rahman *et al* 2010).

Aware of the reported antibiotic activity of and other isothiocyanates and plants containing them, we undertook to determine whether some of them were also active as antibiotics against *Helicobacter pylori*. This bacterium was not discovered until the mid-1980's, a discovery for which the 2005 Nobel Prize in Medicine was just awarded. *H. pylori* is an omnipresent pathogen of human beings in medically underserved areas of the world, and amongst the poorest of poor populations worldwide. It is a major cause of gastritis, and of gastric and duodenal ulcers, and it is a major risk factor for gastric cancer (having been classified as a carcinogen by the W.H.O. in 1993). Cultures of *H. pylori*, it turned out, were extraordinarily susceptible to, and to a number of other isothiocyanates. These compounds had antibiotic activity against *H. pylori* at concentrations up to 1000-fold lower than those which had been used in earlier studies against a wide range of bacteria and fungi. The extension of this finding to human *H. pylori* infection is now being pursued in the clinic, and the prototypical isothiocyanate has already demonstrated some efficacy in pilot studies. (www.tfljournal.org/article.php).

ANTI DIABETIC EFFECT

The progression of diabetes was significantly reduced after MOMtE treatment. In treated rats, both doses of MOMtE induced a significant reduction in serum glucose and nitric oxide, with concomitant increases in serum insulin and protein levels. Furthermore, MOMtE treatment increased antioxidant levels in pancreatic tissue, with concomitant decreases in levels of thiobarbituric acid-reactive substances. Histologic examination of the pancreas from diabetic rats showed degenerative changes in β-cells; MOMtE treatment significantly reversed in the histoarchitectural damage to the islets cells. Conclusion: conclusion, *M. oleifera* exerts protective effects against STZ-induced diabetes. The MOMtE exhibited significant antidiabetic and antioxidant activity and active constituents may be isolated from the extract for evaluation in future clinical studies.(www.ncbi.nlm.nih.gov/pubmed/22103446). K. Suzuki *et al.* (2007) reported anti-diabetic effect of leaves of *Moringa oleifera* on glucose tolerance in Goto-Kakizaki and Wistar rats. *Moringa* significantly decreased the blood glucose in Wistar rats. The area under the curve of changes in the blood glucose was significantly higher in the Goto-Kakizaki rats. The action of MO was greater in Goto-Kakizaki rats than in Wistar rats(B. S. Rathi *et al.* 2006) reported anti-diabetic activity of aqueous extract of *Moringa oleifera* leaves on glycemic control, haemoglobin, total protein, urine sugar, urine protein and body weight(V.I. Hukkeri *et al.* 2006).

ANTIOXIDANT ACTIVITY

Moringa oleifera, a widely cultivated species in India, is an exceptionally nutritious vegetable with a variety of potential uses in treating rheumatism, venomous bites, and microbial infections. In the present study, we investigated the antidiabetic and antioxidant effects of methanol extracts of *M. oleifera* pods (MOMtE) in streptozotocin Diabetic rats were treated (STZ)-induced diabetic albino rats. Methods: days and the antidiabetic effects of mg/kg MOMtE for 21 with 150 or 300 the extract were evaluated by measuring changes in biochemical parameters in the serum and pancreatic tissue. Two phytoconstituents, namely quercetin and kaempferol, were isolated from the MOMtE extract and their structures were determined using nuclear magnetic resonance and infrared spectroscopy. (www.ncbi.nlm.nih.gov/pubmed/22103446)

NEPHROPROTECTIVE ACTIVITY

After 19 days of duration, the mice were fasted overnight and then sacrificed under light ether anaesthesia. Kidney were dissected out, washed immediately with ice-cold saline to remove blood, and the wet weight noted and then stored at -80°C for various biochemical assays, and histological studies. Half of each kidney was processed for biochemical analysis and the other half was used for histological examination. The enzyme levels were assayed using standard CAYMAN Chemicals assay kits, U.S.A. *(Biology and Medicine, Vol 3 (2) Special Issue: 27-35, 2011)*

ANTI CANCER ACTIVITY

Moringa oleifera has been a staple ingredient in the preparation of herbal remedies for hundreds of years, dating back to ancient Ayurvedic medicine in India. Moringa's spread from India into other parts of Asia, Africa, and South America have drawn scientists and researchers to study the tree in detail to learn more about its anti-carcinogenic properties. Not surprisingly, modern science has confirmed the effectiveness of *Moringa* as an anti-cancer plant, just as it has been known for centuries by native cultures. It's powerful combination of anti-cancer nutrients includes Vitamins, Minerals, Complete Proteins, Powerful Antioxidants. *Moringa* is rich with powerful antioxidants**,** which serve the body's health by eliminating free radicals, cancer-causing substances that build up in the body and lead to the onset of cancerous growth. Unlike most other foods rich in antioxidants, *Moringa oleifera* contains a uniquely powerful combination of antioxidants, which work together to make it one of nature's most potent antioxidant sources. In fact, Moringa's dense antioxidant profile is on par or superior to the best sources of antioxidants found in nature, including green teas, wild berries, and other recognized superfoods. *Moringa* has been demonstrated to be an affective antibiotic against harmful bacteria, some of which are known carcinogens. It is not a commonly realized fact that certain bacteria and viruses are carcinogenic, but the World Health Organization has listed many bacterial and viral strains on their list of known cancer-causing agents. Helicobacter pylorus, for example, is a bacterium that lives in the digestive tract and is common in underdeveloped countries around the world. The unique combination of anti-cancer compounds found in *Moringa oleifera* has been demonstrated to effectively fight against H. pylori in low concentrations. It has also been shown to be effective against Burkitt lymphoma**,** a lymphatic cancer that is highly prevalent in people with HIV and AIDS. A clinical study demonstrated that compounds found in the plant inhibited the activation of Burkitt lymphoma cells. Further controlled investigation demonstrates that it dramatically reduces the prevalence of skin papillomas**,** also known as skin tags, which can become malignant in some cases when not treated. Another report published in the Medscape News, explains it's possible effectiveness as as a source of strong anti-cancer compounds for female reproductive disorders, including ovarian cancer**.** Among the most common medicinal plants used in India, only the compounds found in *Moringa oleifera* have been proven effective against a variety of cancers, which, according to the report, include cancers of the pancreas, lung, esophagus, and breast. Studies have also shown that the compounds found in *Moringa oleifera* are effective against preventing the cancer-causing effects of certain compounds that enter the body. Niazimicin, a compound found in the leaves of the tree, blocks the carcinogenic effects of cancer-causing chemicals. (www.moringasource.com/moringa-and-cancer.php)

IMMUNOMODULATORY EFFECT

The aim of the present study was to investigate the immunomodulatory action of methanolic extract of *Moringa oleifera* (MEMO) in an experimental model of immunity. The cellular immunity was evaluated using neutrophil adhesion test, cyclophosphamide induced neutropenia and carbon clearance assay, whereas, humoral immunity was tested by mice lethality test, serum immunoglobulin estimation and indirect haemagglutination assay in animals. Administration of MEMO (250 and 750 mg/kg, po) and *Ocimum sanctum* (100 mg/kg, po) significantly increased the levels of serum immunoglobulins and also prevented the mortality induced by bovine *Pasteurella multocida* in mice. They also increased significantly the circulating antibody titre in indirect haemagglunation test. Moreover, MEMO produced significant increase in adhesion of neutrophils, attenuation of cyclophosphamideinduced neutropenia and an increase in phagocytic index in carbon clearance assay. From the above results, it can be concluded that MEMO stimulate both cellular and humoral immune response. However, low dose of MEMO was found to be more effective than the high dose.

ANTI-INFLAMMATORY ACTIVITY

Cáceres *et al.* (1992) reported anti-inflammatory activity from the hot water infusions of flowers, leaves, roots, seeds and stalks or bark of *Moringa oleifera* using carrageenan-induced hind paw edema in rats. B. Medhi *et al.* (1996) evaluated anti-inflammatory activity of methanol extract of Moringa oleifera root bark using carrageenin induced paw edema in mice as animal model. M. Ndiaye *et al.* (2002) tested anti-inflammatory action of an aqueous extract of root of *Moringa oleifera* in rats using indomethacin (10 mg/kg) as standard drug and oedema was induced in the rat-paw by subcutaneous injection of carrageenin. At a dose of 750 mg/kg the *Moringa oleifera* treatment significantly inhibited the development of oedema at 1, 3 and 5 hours (reduction by 53.5, 44.6 and 51.1% respectively). S.G. Mahajan *et al.* (2007) investigated anti – inflammatory activity from the ethanolic extract of seeds of *Moringa oleifera*. The extract was pharmacologically evaluated against immunemediated inflammatory responses in toluene diisocyanate (TDI as antigen)-induced asthma in Wistar rats. S.G. Mahajan *et al.* (2007) reported anti-arthritic activity of ethanolic extract of seeds of *Moringa oleifera* Lam. in adjuvant-induced arthritis in adult female Wistar rats. K.V. Sashidhara *et al.* (2009) from the roots of *Moringa oleifera* isolated and characterized aurantiamide acetate 4 and 1,3-dibenzyl urea 5. Isolated compounds inhibited the production of TNF-alpha and IL-2. S.G. Mahajan *et al.* (2009) evaluated anti-inflammatory activity from the n-butanol extract of the seeds of *Moringa oleifera* against ovalbumin-induced airway inflammation in guinea pigs. The crude methanol extract of root by oral administration inhibits carrageenan-induced rat paw oedema in a dose dependent manner.(www.scholarsresearchlibrary.com)

ANTIFERTILITY ACTIVITY

A.O. Prakash *et al.* (1987) investigated antifertility activity from the aqueous extract of *Moringa oleifera* roots. The effect of aqueous extract has been studied on histoarchitecture of the uterus during pre and post-implantation stages in rats. S. Shukla *et al.* (1988) reported anti-implantation activity from the aqueous extract of Moringa oleifera in female reproductive organs of cyclic rats and also antifertility activity from the aqueous extract of the roots of the plant. Oral administration of extract progressively increased the uterine wet weight of bilaterally ovariectomized rats. This estrogenic activity was supported by stimulation of uterine histo-architecture. When the extract was given conjointly with estradiol dipropionate (EDP), there was a successive reduction in the uterine wet weight when compared to the gain with EDP alone and uterine histological structures were also inhibited. S. Shukla *et al.* (1989) investigated antifertility effect of aqueous extract of *Moringa oleifera* roots was studied histologically on the genital tract of ovariectomized rats in the presence and absence of estradiol dipropionate and progesterone. Administration of the extract itself stimulated the uterine histoarchitecture as revealed by increases in the height of luminal epithelium, well developed glands, loose stroma and rich vascularity. The cervix showed metaplastic changes in the epithelium with marked keratinization. In the vagina, cornification was very prominent, rugae increased and stroma was loose. Conjoint administration of the extract with estradiol showed a synergistic action, and an inhibition was observed when administered conjointly with progesterone. D. Nath *et al.* (1992) investigated antifertility property from the aqueous and 90% ethanol extracts

of the plant in rats orally dosed for 10 days after insemination with special reference to effects on foetal development. Leaf extracts of *Moringa oleifera* were 100% abortive at doses equivalent to 175 mg/kg of starting dry material.(www.scholarsresearchlibrary.com)

HEPATOPROTECTIVE ACTIVITY

U.K. Mazumder *et al.* (1999) investigated hematological along with hepatorenal functions of methanolic extract of *Moringa oleifera* roots. Doses of the crude extract (CE) on liver and kidney functions and hematological parameters in mice were studied. No alteration in hematological and biochemical parameters at low and moderate dose level of daily and low dose level of weekly treatment of the extract was observed. However, the extract at moderate dose level in weekly treatment changed serum aminotransferase and plasma cholesterol levels significantly. High dose in addition to the above parameters changed total bilirubin, non protein nitrogen, blood urea and plasma protein. High dose of daily treatment and moderate and high dose of weekly treatment of CE increased WBC count and decreased clotting time significantly. L. Pari & N.A. Kumar (2002) evaluated hepatoprotective effect of ethanolic extract leaves of *Moringa oleifera* on liver damage induced by antitubercular drugs such as isoniazid (INH), rifampicin (RMP), and pyrazinamide (PZA) in rats. Oral administration of the extract showed a significant protective action made evident by its effect on the levels of glutamic oxaloacetic transaminase (aspartate aminotransferase), glutamic pyruvic transaminase (alanine aminotransferase), alkaline phosphatase, and bilirubin in the serum; lipids, and lipid peroxidation levels in liver. This observation was supplemented by histopathological examination of liver sections.

A.A. Hamza (2007) reported hepatoprotective action of *Moringa oleifera* seeds against Diclofenac (DIC)-induced hepatic toxicity in male albino rats. Administration of DIC at 150 mg/kg developed acute hepatic damage, as demonstrated by increased serum alanineaminotransferase (ALT) activity and histopathological changes. In addition, DIC treatment resulted in an increase in the hepatic malonialdehyde level and depletion in total antioxidant capacity, reduced glutathione content, catalase, and superoxide dismutase activities. Treatment with herbal extracts for 30 days before DIC treatment significantly ameliorated the indices of hepatotoxicity induced by DIC. S. Fakurazi *et al.* (2008) reported hepatoprotective action of *Moringa oleifera* against acetaminophen induced liver injury in Sprague-Dawley rats using silymarin as standard drug. The hepatoprotective activity of Moringa extract was observed following significant histopathological analysis and reduction of the level of alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP) in groups pretreated with Moringa compared to those treated with Acetaminophen alone. Meanwhile, the level of glutathione (GSH) was found to be restored in Moringa treated animals compared to the groups treated with Acetaminophen alone. A.A. Hamza (2010) evaluated the effect of *Moringa oleifera* seed extract on liver fibrosis. Liver fibrosis was induced by the oral administration of 20% carbon tetrachloride (CCl4). Simultaneously, *M.oleifera* seed extract (1g/kg) was orally administered daily. The administration of Moringa seed extract decreased the CCl4-induced elevation of serum aminotransferase activities and globulin level. The elevations of hepatic hydroxyproline content and myeloperoxidase activity were also reduced by Moringa treatment. Furthermore, the immunohistochemical study showed that Moringa markedly reduced the numbers of smooth muscle alpha-actin-positive cells and the accumulation of collagens I and III in liver.(A. A. Hamza, 2007).

CARDIOVASCULAR ACTIVITY

S. Faizi *et al.* (1994) reported the isolation of two nitrile glycosides from the ethanolic extracts of Moringa oleifera leaves, niazirin and niazirinin and three mustard oil glycosides. Compounds such as 4-[(4'-O-acetyl-alpha-L-rhamnosyloxy) benzyl]isothiocyanate, niaziminin A and B showed hypotensive activity (S. Faizi *et al.* 1995) reported six new and three synthetically known glycosides from the ethanolic extract of the leaves of *Moringa oleifera*. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, Thiocarbamates showed hypotensive activity (S. Faizi *et al.* 1998) isolated thiocarbamate and isothiocyanate glycosides. These compounds showed promising hypotensive activity **(**S. Ghasi *et al.* 2000) investigated hypocholesterolemic effect of crude leaf extract of Moringa oleifera. The effect on the serum

cholesterol was statistically significant. No significant effect on serum total protein was observed. However, the crude extract increased serum albumin by 15.22% (M. Ndong *et al.* 2007) tested preventive effects of *Moringa oleifera* on hyperlipidemia caused by iron deficiency in male Wistar rats (N. Ara *et al.* 2008) reported comparative effects of ethanolic extracts of leaves of Moringa oleifera with atenolol on serum cholesterol level, serum triglyceride level, blood glucose level, heart weight and body weight of adrenaline induced rats. Above mentioned biochemical parameters were established and the relationship between them was measured. The Moringa oleifera leaves extract made significant changes in each cardiovascular parameter after properinvestigation (P. Chumark *et al.* 2008) reported antiatherosclerotic and hypolipidaemic activity of Moringa oleifera leaves using simvastatin as standard drug. The extract significantly prolonged the lagtime of conjugated diene (CD) formation and inhibited thiobarbituric acid reactive substances (TBARS) formation in both in vitro and ex vivo experiments in a dose-dependent manner. In hypercholesterol-fed rabbits, it significantly lowered the cholesterol levels and reduced the atherosclerotic plaque formation to about 50 and 86%, respectively(M. Nandave *et al.* 2009) investigated cardioprotective effect of lyophilized hydroalcoholic extract of *Moringa oleifera* in the isoproterenol (ISP)-induced model of myocardial infarction in male wistar albino rats. Chronic treatment with Moringa resulted in significant favorable modulation of the biochemical enzymes (superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase, and creatine kinase-MB) but failed to demonstrate any significant effect on reduced glutathione compared to the ISP control group. Moringa treatment significantly prevented the rise in lipid peroxidation in myocardial tissue (M. Nandave *et al.*2009).

ANTI-ULCER ACTIVITY

S. Debnath & D. Guha **(2007)** reported anti-ulcer effect of aqueous extract of *Moringa oleifera* leaves on adult holtzman albino rats of either sex using ondansetron as standard drug (S. Debnath *et al* 2007)

ANALGESIC, ANTIPYRETIC & WOUND HEALING ACTIVITY

B. Medhi *et al.* (1996) investigated methanolic extract of *Moringa oleifera* root bark in mice using acetic acid-induced writhing method for analgesic activity (S. Debnath et al. 2007) B.S. Rathi *et al.* (2006) evaluated wound healing property from the aqueous extract of leaves of Moringa oleifera in male Swiss albino mice. Significant increase in wound closure rate, skinbreaking strength, granuloma breaking strength, hydroxyproline content, granuloma dry weight and decrease in scar area was observed (B. S. Rathi *et al.* 2006) reported antipyretic and wound healing activity from the ethanolic and ethyl acetate extracts of *Moringa oleifera* leaves. The ethanolic and ethyl acetate extracts of seeds showed significant antipyretic activity in rats, whereas ethyl acetate extract of dried leaves showed significant wound healing activity (10% extracts in the form of ointment) on excision, incision and dead space (granuloma) wound models in rats (V.I. Hukkeri *et al.* 2006).

DIURETIC & ANTIUROLITHIATIC ACTIVITY

A Cáceres *et al.* **(1992)** reported diuretic activity from hot water infusions of flowers, leaves, roots, seeds and stalks or bark of *Moringa oleifera*. The extracts of Moringa were administered orally in rats and diuretic activity is determined by urine output in metabolic cages (R.V. Karadi *et al.* 2006) investigated antiurolithiatic activity from the aqueous and alcoholic extract of *Moringa oleifera* root-wood on calcium oxalate urolithiasis in male Wistar albino rats. Oral administration of aqueous and alcoholic extract of Moringa oleifera significantly reduced the elevated urinary oxalate, showing a regulatory action on endogenous oxalate synthesis. The increased deposition of stone forming constituents in the kidneys of calculogenic rats was also significantly lowered by curative and preventive treatment using aqueous and alcoholic extracts reported antiurolithiatic property from the aqueous and alcoholic extract of the root bark of Moringa oleifera. Both the extracts significantly lowered the urinary excretion and kidney retention levels of oxalate, calcium and phosphate. Moreover, elevated serum levels of urea nitrogen, creatinine and uric acid were significantly reduced by the extracts (R.V. Karadi *et al.* 2008).

CNS ACTIVITY

K. Ray *et al.* (2003) investigated anticonvulsant activity from the aqueous extract of Moringa oleifera roots. The effect was studied on penicillin (PCN) induced convulsion, locomotor behaviour, brain serotonin (5-HTT), dopamine (DA) and norepinephrine (NE) level in Holtzman strain adult albino rats (R. Ganguly & D. Guha (2008) evaluated ethanolic extract of *Moringa oleifera* leaves in alteration of brain monoamines (norepinephrine, dopamine and serotonin) & EEG wave pattern in Alzheimer's disease in rats. Treatment with Moringa oleifera leaf extract restores the monoamine levels of brain regions to near control levels (R. Ganguly *et al.*2008)

LOCAL ANAESTHETIC ACTIVITY

B. Medhi *et al.* (1996) investigated methanolic extract of *Moringa oleifera* root bark in frog and guinea pig models for local anaesthetic activity. The local anaesthetic activity was seen in both animal models

ANTHELMINTIC ACTIVITY

T. Rastogi *et al.* (2009) reported anthelmintic activity of *Moringa oleifera*. Ethanolic extracts of *Moringa oleifera* were taken for anthelmintic activity against Indian earthworm Pheritima posthuma. Various concentrations of extract were tested and results were expressed in terms of time for paralysis and time for death of worms. Piperazine citrate (10 mg/ml) was used as a reference standard and distilled water as a control group.

CONCLUSION

The scientific research on *Moringa oleifera* suggests a huge biological potential of this plants. It is strongly believed that detailed information as presented in this review on the phytochemical and various biological functions of these plants might provide detailed evidence for the use of these plants in different medicines.

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