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AN OVERVIEW LITERATURE OF MEDICAL SUPPORT, FOOD, CURATIVE, AND PROPHYLACTIC PROPERTIES OF *MORINGA OLIFERA*

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ABSTRACT

The aim of this literature review was to provide advance research information for the future scientists to discover new drug molecules from the medicinal plant, *Moringa oleifera* Lam. (Moringaceae). *Moringa oleifera*, or the horseradish tree, is a pan-tropical species that is known by such regional names as benzolive, drumstick tree, kelor, marango, mlonge, mulangay, nébéday, saijhan and sajna. Over the past two decades, many reports have appeared in mainstream scientific journals describing its nutritional and medicinal properties. Its utility as a non-food product has also been extensively described, but will not be discussed herein, (e.g. lumber, charcoal, fencing, water clarification, lubricating oil). As with many reports of the nutritional or medicinal value of a natural product, there are an alarming number of purveyors of "healthful" food who are now promoting *M. oleifera* as a panacea. While much of this recent enthusiasm indeed appears to be justified, it is critical to separate rigorous scientific evidence from anecdote. Those who charge a premium for products containing *Moringa* spp. must be held to a high standard. Those who promote the cultivation and use of *Moringa* spp. in regions where hope is in short supply must be provided with the best available evidence, so as not to raise false hopes and to encourage the most fruitful use of scarce research capital. It is the purpose of this series of brief reviews to: (a) critically evaluate the published scientific evidence on *M. oleifera*, (b) highlight claims from the traditional and tribal medicinal lore and from non-peer reviewed sources that would benefit from further, rigorous scientific evaluation and (c) suggest directions for future clinical research that could be carried out by local investigators in developing regions. The plant

provides a rich and rare combination of zeatin, quercetin, beta-sitosterol and kaempferol. In addition to its high nutritional value, *Moringa oleifera* Lam is very important for its medicinal value. Various parts of this plant such as leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine. This review gives the scientific information regarding pharmacological potentials of *Moringa oleifera* Lam. (Moringaceae).

KEYWORDS: *Moringa oleifera,* eatin, quercetin, beta-sitosterol and kaempferol.

INTRODUCTION

Moringa oleifera is the most widely cultivated species of a monogeneric family, the Moringaceae that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree (also known as the horseradish tree, drumstick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nébéday, saijhan, sajna or Ben oil tree), was utilized by the ancient Romans, Greeks and Egyptians; it is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan, and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics. All parts of the Moringa tree are edible and have long been consumed by humans. According to Fuglie (47) the many uses for Moringa include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification (powdered seeds). Moringa seed oil (yield

30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication and in the manu-facture of perfume and hair care products. In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern.

Nutrition

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Three non-governmental organizations in particular—Trees for Life, Church World Service and Educational Concerns for Hunger Organization—have advocated Moringa as "natural nutrition for the tropics." Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration and reportedly without loss of nutritional value. Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce.

A large number of reports on the nutritional qualities of Moringa now exist in both the scientific and the popular literature. Any readers who are familiar with Moringa will recognize the oft-reproduced characterization made many years ago by the Trees for Life organization, that "ounce-for-ounce, Moringa leaves contain more Vitamin A than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges and more potassium than bananas," and that the protein quality of Moringa leaves rivals that of milk and eggs. These readers will also recognize the oral histories recorded by Lowell Fuglie in Senegal and throughout West Africa, who reports (and has extensively documented on video) countless instances of lifesaving nutritional rescue that are attributed to Moringa (47,48). In fact, the nutritional properties of Moringa are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaf powder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled and well documented clinical studies are still clearly of great value.

Phytochemistry

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 (10,38). 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 (47) and others and will be the subject of a future review in this series. leaves and young buds of the plant are used as vegetable and can be rubbed on the temples for relieving headache while root and root bark are regarded as anti scorbutic and can be used externally as counterirritant.[2] The eye diseases are treated with the juice of the leaves with honey.[3] The plant is also known to possess high nutritional value and is used in a folklore medicine to treat various ailments related to pain and inflammation.[4] Dried seeds of *Moringa oleifera* are used in ophthalmic preparation, venereal affection anti-inflammatory and purgative and as tonic.[5] The alcoholic extract of the leaves of *Moringa oleifera* are reported to have analgesic activity[5] and the aqueous extract of *Moringa olifera* roots also shows antifertility profile.[6] The plant is reported to possess wide range of pharmacological effects that include antitumor[7], antipyretic[1], antispasmodic, diuretic[8], antiulcer[9], hypertensive[10], hypolipidemic[11], Hepatoprotective[12], antifungal[13] and antibacterial activities.[14] The purpose of this review is to summarize the pharmacological properties of different parts of the plant, *Moringa oleifera.*

Disease Treatment and Prevention

The benefits for the treatment or prevention of disease or infection that may accrue from either dietary or topical administration of Moringa preparations (e.g. extracts, decoctions, poultices, creams, oils, emollients, salves, powders, porridges) are not quite so well known (116). Although the oral history here is also voluminous, it has been subject to much less intense scientific scrutiny and it is useful to review the claims that have been made and to

assess the quality of evidence available for the more well-documented claims. The readers of this review are encouraged to examine two recent papers that do an excellent job of contrasting the dilemma of balancing evidence from complementary and alternative medicine (e.g. traditional medicine, tribal lore, oral histories and anecdotes) with the burden of proof required in order to make sound scientific judgments on the efficacy of these traditional cures (138,154). Clearly much more research is justified, but just as clearly this will be a very fruitful field of endeavor for both basic and applied researchers over the next decade.

Antibacterial and Antifungal Efficiency

A considerable reduction in the growth of test bacteria was observed by distillate of *M. oleifera* suggesting antibacterial effect. Among bacteria tested, more inhibition was observed in case of *E. coli* followed by *S. aureus, K. pneumoniae, P. aeruginosa and B. subtilis.* Inhibition of fungi was also observed as reduced colony diameter in plates poisoned with distillate as compared to control plates. More inhibition of *A. niger* was found followed by *A. oryzae, A. terreus and A. nidulans*. The antimicrobial activity and antifungal activities of steam distillate of *M. oleifera* might be possibly due to the essential oil fraction of the plant material present in the distillate fraction.

Analgesic Activity and Local Anaesthetic Activity

The analgesic activity of alcoholic extract of *M. oleifera* and its various fractions as Petroleum ether, Ethyl acetate, Diethyl ether, n-Butanol were carried out by using Hotplate and Tail immersion method. Amongst alcoholic extract and its various fractions of seeds of *M. oleifera* alcoholic extract showed potent analgesic activity which is comparable to that of aspirin at the dose of 25 mg/kg of body weight. From this study, it can be concluded that the seeds of *M. oleifera* Lam. possess marked analgesic activity and is equipotent to standard drug (Aspirin) which establishes the use of *M. oleifera* seeds as regular analgesic.[5] The local anaesthetic activity of the methanol extract of *M. oleifera* was tested in frog and guinea pig models and it was seen that in both animals, the plant (root bark) has produced significant local anaesthetic activity.

Anti-Oxidant Effect

The antioxidant property of *Moringa* may be due to the presence of phenolic compounds that was confirmed by phytochemical screening of the hydro-ethanolic extract. In this respect, *Moringa* pods contain important bioactive compounds including glucosinolates, isothiocyanates, thiocarbamates and flavonoids.[16] These compounds quench ROS, chelate

metal ions and regenerate membrane-bound antioxidants.[17] β-carotene, the major component reported from the drumsticks of the plant[16] and vitamin A and C present in *M. oleifera* serve as an explanation for their mode of action in the induction of antioxidant profiles in the present investigation. The biochemical basis of the chemopreventive potency of *M. oleifera* extract may be attributed to the synergistic action of the constituents of the extract and the induction of Phase-II enzymes (GSTs) and antioxidant enzymes, which might be implicated in the anticarcinogenic activity. The aqueous extract of *Moringa oleifera* exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl (DPPH) free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The free radical scavenging effect of *Moringa oleifera* leaf extract was comparable with that of the reference antioxidants. The extracts of *Moringa oleifera* both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage.

Anti-Inflammatory and Antinociceptive Activity

The anti-inflammatory action of an aqueous extract of root in rats with weight between 120 and 160 g was investigated by Ndiaye *et al.*[28] At a dose of 750 mg/kg the *M. oleifera* treatment significantly inhibited the development of oedema at 1, 3 and 5 hours (reduction by 53.5, 44.6 and 51.1% respectively). Increasing the dose of *M. oleifera* to 1000 mg/kg did not increase the inhibitory effect on oedema development at 1 and 3 hours, whereas this dose potentiated the oedema at 5 hours.

Gastric Ulcer Protective Activity

Das *et al*., studied the possible antiulcer effects of water extracts of *M. oleifera* in two animal models of ulcers. The water extract of leaves was tested for antiulcer activity at the dose level of 200 mg and 400 mg/kg p.o. in pyloric ligation and ibuprofen induced gastric ulcer models. The severity of gastric ulceration in both the models was assessed based on the means of ulcer index. Both the models produced moderate to severe ulcers in control group of animals; in that the maximum was by pylorus ligation method. Both famotidine and the extract of *M. oleifera* significantly ($p<0.001$) reduced the ulcer index as compared to control group in both ulcer models. The antiulcer effect of *M. oleifera* was comparable with that of the standard drugs in pylorus ligation and ibuprofen induced ulcer methods. Famotidine and *M. oleifera* extract significantly ($p<0.05$) reduced the free acidity and total acidity of gastric juice. It is equally potent when compared to famotidine.

Cardioprotective Activity

Nandave *et al*., evaluated cardioprotective effect of lyophilized hydroalcoholic extract of *M. oleifera* in the isoproterenol (ISP)-induced model of myocardial infarction. Chronic treatment Biswas *et al.*, IJPSR, 2012; Vol. 3(2): 305-310 ISSN: 0975-8232 Available online on www.ijpsr.com 308 with *M. oleifera* demonstrated mitigating effects on ISP-induced hemodynamic [HR, (+) LV dP/dt, (-) LV dP/dt, and LVEDP] perturbations. Chronic *M. oleifera* treatment resulted in significant favorable modulation of the biochemical enzymes (superoxide dismutase, catalase, glutathione peroxidase, lactate dehydro- genase 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.

Anti-helmentic, Hypolipidemic and Antiathero- sclerotic Activities

It was observed that the plant showed potent anthelmentic activity and caused paralysis within 6-15 min while death is comparable with that of piperazine citrate as death of worms was observed at 64 min 34. Chumark *et al*., investigated the hypolipidaemic and antiatherosclerotic activities of *M. oleifera* leaf extract. They found that in hypercholesterol-fed rabbits, at 12 weeks of treatment, the water extract of the plant significantly ($P<0.05$) lowered the cholesterol levels and reduced the atherosclerotic plaque formation to about 50% and 86%, respectively and these effects were at degrees comparable to those of simvastatin.[35] The methanolic extract of *M. oleifera* (150, 300 and 600 mg/kg, p.o.) and simvastatin (4 mg/kg, p.o.) along with hyperlipidemic diet were administered to Albino Wistar rats for 30 days in order to observe hypolipidaemic effect. It was found that the serum cholesterol, triacylglyceride, VLDL, LDL and atherogenic index were reduced by *M. oleifera* and simvastatin but HDL level was increased as compared to the corresponding high fed cholesterol diet group (control). *M. oleifera* was also found to increase the excretion of fecal cholesterol. Thus, it can be concluded that *M. oleifera* possesses a hypolipidemic effect.

Wound Healing Activity

The aqueous extract of leaves of *M. oleifera* was investigated for its wound healing activity. The extract was studied at dose level of 300 mg/kg body weight using resutured incision, excision and dead space wound models in rats. The prohealing actions seem to be due to increased collagen deposition as well as better alignment and maturation. From the study

results obtained, it may be concluded that the aqueous extract of *M. oleifera* has significant wound healing property.

Hypotensive and Spasmolytic Activities

Bioassay directed fractionation of an ethanolic extract of *M. oleifera* leaves showing hypotensive activity led to the isolation of two nitrile glycosides, niazirin[1] and niazirinin[2] and three mustard oil glycosides, 4-[(4'-O-acetyl-alpha-L-rhamnosyloxy) benzyl] isothiocyanate[4], niaziminin A, and niaziminin B. Isothiocyanate 4 and the thiocarbamate glycosides niaziminin A and B showed hypotensive activity while nitrile glycosides 1 and 2 were found to be inactive in this regard.[32] Moreover, spasmolytic activity exhibited by the constituents of the plant provides a scientific basis for the traditional uses of the plant in gastrointestinal motility disorders.

Antiurolithiatic Activity

The effect of oral administration of aqueous and alcoholic extract of *M. oleifera* root-wood on calcium oxalate urolithiasis has been studied in male Wistar albino rats. Ethylene glycol feeding resulted in hyperoxaluria as well as increased renal excretion of calcium and phosphate. Supplementation with aqueous and alcoholic extract of *M. oleifera* root-wood 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. Thus the results indicate that the root-wood of *M. oleifera* is endowed with antiurolithiatic activity.

Cancer Prevention

Moringa species have long been recognized by folk medicine practitioners as having value in tumor therapy. we examined compounds[1] and[2] for their cancer preventive potential. Recently,[1] and the related compound[3] were shown to be potent inhibitors of phorbol ester. (TPA)-induced Epstein-Barr virus early antigen activation in lymphoblastoid (Burkitt's lymphoma) cells (57,104). In one of these studies,[3] also inhibited tumor promotion in a mouse two-stage DMBA-TPA tumor model (104). In an even more recent study, Bharali and colleagues have examined skin tumor prevention following ingestion of drumstick (Moringa seedpod) extracts (12). In this mouse model, which included appropriate positive and negative controls, a dramatic reduction in skin papillomas was demonstrated. Thus, traditional practice has long suggested that cancer prevention and therapy may be achievable

with native plants. Modern practitioners have used crude extracts and isolated bioactive compounds. The proof required by modern medicine has not been realized because neither the prevention of cancer nor the modification of relevant biomarkers of the protected state has been adequately demonstrated in human subjects. Does this mean that it doesn't work? No. It may well work, but more rigorous study is required in order to achieve a level of proof required for full biomedical endorsement of Moringa as, in this case, a cancer preventative plant.

Other Activities

The *Moringa* powder was also exploited as anti-AIDS agent. Anti-HIV activity could be due to its immunostimulatory effect. It is also known that polysaccharide isolated from the hot aqueous extract of mature pods of *M. oleifera* showed significant macrophage activity through the release of nitric oxide on mouse monocyte cell line. Hence, it speculated that the immunostimulatory activity is due to presence of its constituent in methanolic extract of *Moringa oleifera*. It was also found that both low dose (25 mg/kg, p.o.) as well as high dose (750 mg/kg, p.o.) of *M. oleifera* stimulates immune system by acting through cellular and humoral immunity in experimental models of immunity in animals. However, low dose was found to be most effective than the high dose. This could be due to the presence of toxicant such as isothiocyanate and glycoside cyanides that may pose stress at high concentration and hence reducing the antioxidant potential of *Moringa oleifera.*

CONCLUSION

Moringa oleifera Lam., an important medicinal plant, is one of the most widely cultivated species of the family Moringaceae. Leaves, barks, roots, stems, buds, flowers etc. have been used for different human ailments. Pharmacologically reported effects include anti-bacterial, antifungal, anti-inflammatory and analgesic, antioxidant, hypotensive, anti-ulcer, anaesthetic cardioprotective, antiurolithiatic activity and wound healing activity etc. This review summarizes only some pharmacological activities of *Moringa oleifera* which can be investigated further to isolate active compounds for novel herbal medicine.

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