Received on 05 January, 2014; received in revised form, 27 February, 2014; accepted, 30 March, 2014; published 01 April, 2014

PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITIES OF *MORINGA OLEIFERA*

Alemayehu Toma* and Serawit Deyno

Pharmacology Unit, School of medicine, Hawassa University, Hawassa, Ethiopia

Keywords:
Moringa Oleifera, Phytochemistry, Pharmacological actions

Correspondence to Author:
Alemayehu Toma
Pharmacology Unit, School of medicine, Hawassa University, Hawassa, P o box 1560, Ethiopia

Email: alexpharma99@yahoo.com

ABSTRACT: *Moringa oleifera* can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought. It tolerates a wide range of rainfall with minimum annual rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0–9.0. *Moringa* leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids. In the Philippines, it is known as 'mother's best friend' because of its utilization to increase woman's milk production and is sometimes prescribed for anemia. *Moringa oleifera* has both nutritional and multimedicinal activity. Some of medicinal effects includes antimicrobial, antifungal, antihypertensive, antihyperlipidemic, antihyperglycemic, antipyretic, wound healing, antitumor, anticancer, antiinflammatory and for purification of water. Since Moringa oleifera can survive drought condition and its diet content is superior to vitamins and even than milk in protein content its nutritional benefit is indivisible. However, more rigorous study is required in order to achieve a level of proof required for full biomedical endorsement of *Moringa oleifera*.

INTRODUCTION: *Moringa oleifera* Lam (syn. *M. ptreygosperma* Gaertn.) is one of the best known and most widely distributed and naturalized species of a monogeneric family *Moringaceae* [1]. The tree ranges in height from 5 to 10 m. It is found wild and cultivated throughout the plains, especially in hedges and in house yards, thrives best under the tropical insular climate, and is plentiful near the sandy beds of rivers and streams [2]. It can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought.

QUICK RESPONSE CODE

DOI:
10.13040/IJPSR.0975-8232.1(4).222-31

Article can be accessed online on:
www.ijpjournal.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.1(4).222-31

It tolerates a wide range of rainfall with minimum annual rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0–9.0 [3]. *Moringa* leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants; and thus enhance the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [4]. In the Philippines, it is known as 'mother's best friend' because of its utilization to increase woman's milk production and is sometimes prescribed for anemia [5].

A number of medicinal properties have been ascribed to various parts of this highly esteemed tree **(Table 1).** Almost all the parts of this plant: root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil have been used for various ailments in the indigenous medicine of South Asia, including the treatment of inflammation and infectious diseases

along with cardiovascular, gastrointestinal, hematological and hepatorenal disorders[2,6].

The seeds of *Moringa* are considered to be antipyretic, acrid, bitter and reported to show antimicrobial activity [2]. The seed can be consumed fresh as peas; or pounded, roasted, or pressed into sweet, non-desiccating oil, commercially known as 'Ben oil' of high quality. The unique property is the ability of its dry, crushed seed and seed press cake, which contain polypeptides, to serve as natural coagulants for water treatment [7].

Table 1. Some common medicinal uses of different parts of *Moringa oleifera*

Plant part	Medicinal Uses
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,
Leave	Purgative, applied as poultice to sores, rubbed on the temples for headaches, used for piles, fevers, sore throat, bronchitis, eye and ear infections, scurvy and catarrh; leaf juice is believed to control glucose levels, applied to reduce glandular swelling
Stem bark	Rubefacient, vesicant and used to cure eye diseases and for the treatment of delirious patients, prevent enlargement of the spleen and formation of tuberculous glands of the neck, to destroy tumors and to heal ulcers. 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
Gum	Used for dental caries, and is astringent and rubefacient; Gum, mixed with sesame oil, is used to relieve headaches, fevers, intestinal complaints, dysentery, asthma and sometimes used as an abortifacient, and to treat syphilis and rheumatism
Flower	High medicinal value as a stimulant, aphrodisiac, abortifacient, cholagogue; used to cure inflammations, muscle diseases, hysteria, tumors, and enlargement of the spleen; lower the serum cholesterol, phospholipid, triglyceride, VLDL, LDL cholesterol to phospholipid ratio and atherogenic index; decrease lipid profile of liver, heart and aorta in hypercholesterolaemic rabbits and increased the excretion of faecal cholesterol
Seed	Seed extract exerts its protective effect by decreasing liver lipid peroxides, antihypertensive compounds thiocarbamate and isothiocyanate glycosids have been isolated from the acetate phase of the ethanolic extract of *Moringa* pods

PHYTOCHEMISTRY: *Moringa oleifera* is rich in compounds containing the simple sugar, rhamnose and a fairly unique group of compounds called glucosinolates and isothiocyanates [8]. The stem bark has been reported to contain two alkaloids, namely moringine and moringinine [9]. Vanillin,β-sitosterol [14], β-sitostenone, 4-hydroxymellin and octacosanoic acid have been isolated from the stem of *M. oleifera* [10]. Purified, whole-gum exudate from *M. oleifera* has been found to contain L-arabinose, -galactose, -glucuronic acid, and L-rhamnose, -mannose and -xylose, while a homogeneous, degraded-gum polysaccharide consisting of L-galactose, -glucuronic acid and L-mannose has been obtained on mild hydrolysis of the whole gum with acid. Flowers contain nine amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin and kaempferat; the ash is rich in potassium and

calcium. They have also been reported to contain some flavonoid pigments such as alkaloids, kaempherol, rhamnetin, isoquercitrin and kaempferitrin [6, 10].

Antihypertensive compounds thiocarbamate and isothiocyanate glycosides have been isolated from the acetate phase of the ethanol extract of *Moringa* pods [11]. The cytokinins have been shown to be present in the fruit. A new *O*-ethyl-4-(ά-L-rhamnosyloxy)benzyl carbamate [11] together with seven known bioactive compounds, 4(ά- L-rhamnosyloxy)-benzyl isothiocyanate[3], niazimicin[4], 3-*O*-(6′-*O*-oleoyl-β-D-glucopyranosyl)-β-sitosterol [15], β-sitosterol-3-*O*-β-D-glucopyranoside [16], niazirin [12], β-sitosterol [14] and glycerol-1-(9-octadecanoate) [13] have been isolated from the ethanol extract of the *Moringa* seed [12]. **Figure 1** shows the structures of selected phytochemicals from *Moringa*.

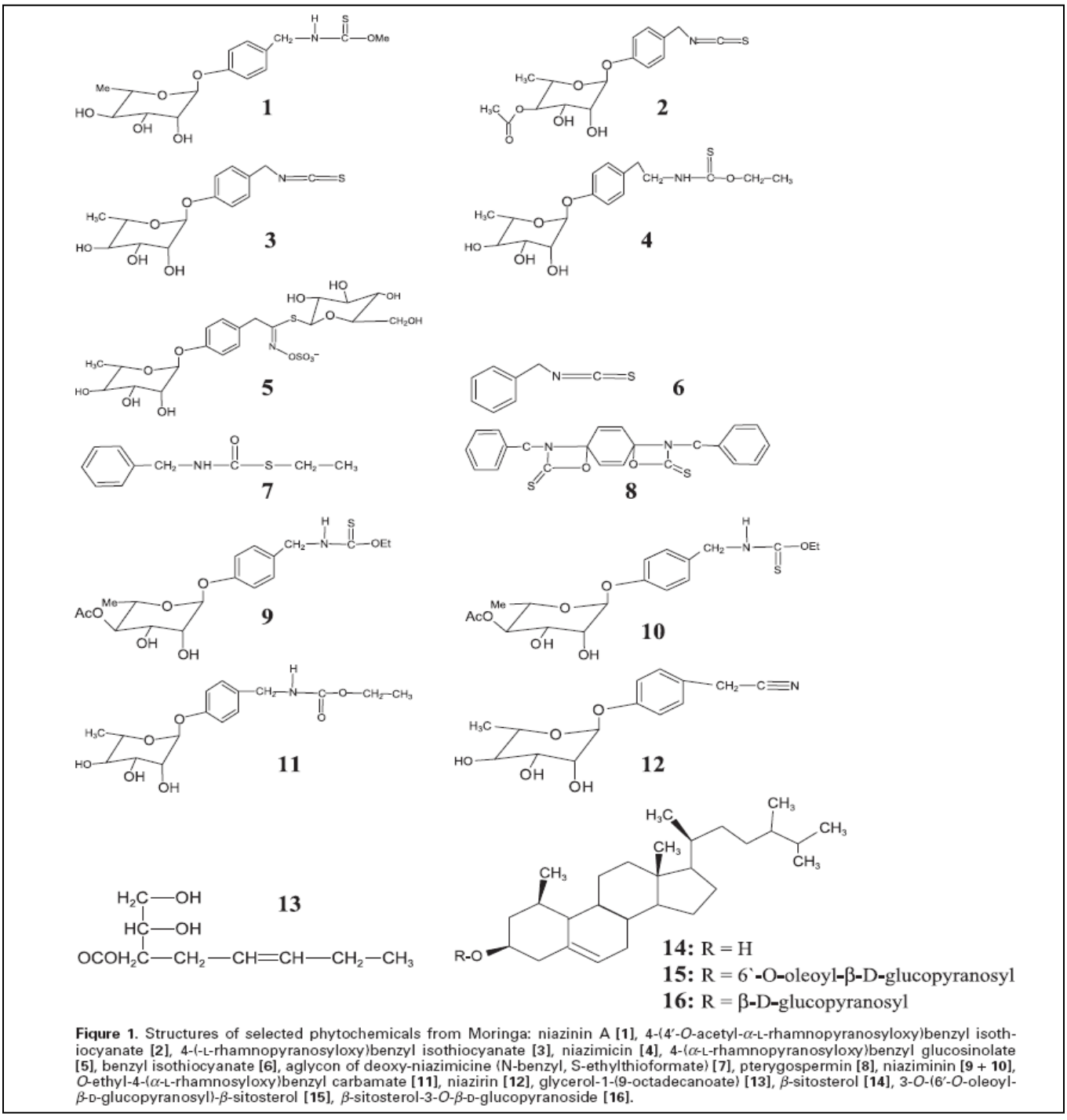

Figure 1. Structures of selected phytochemicals from Moringa: niazinin A **[1]**, 4-(4′-*O*-acetyl-*α*-L-rhamnopyranosyloxy)benzyl isothiocyanate **[2]**, 4-(-L-rhamnopyranosyloxy)benzyl isothiocyanate **[3]**, niazimicin **[4]**, 4-(*α*-L-rhamnopyranosyloxy)benzyl glucosinolate **[5]**, benzyl isothiocyanate **[6]**, aglycon of deoxy-niazimicine (N-benzyl, S-ethylthioformate) **[7]**, pterygospermin **[8]**, niaziminin **[9 + 10]**, *O*-ethyl-4-(*α*-L-rhamnosyloxy)benzyl carbamate **[11]**, niazirin **[12]**, glycerol-1-(9-octadecanoate) **[13]**, *β*-sitosterol **[14]**, 3-*O*-(6′-*O*-oleoyl-*β*-D-glucopyranosyl)-*β*-sitosterol **[15]**, *β*-sitosterol-3-*O*-*β*-D-glucopyranoside **[16]**.

Lately, interest has been generated in isolating hormones/growth promoters from the leaves of *M. oleifera*. Nodulation of black-gram (*Vigna munga* L.) has been shown to increase vigorously with the application of an aqueous-ethanol extract of *M. oleifera* leaves, although the nature of the active ingredient is still unknown. *Moringa* leaves act as a good source of natural antioxidant due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids. The high concentrations of ascorbic acid, oestrogenic substances and β-sitosterol [16], iron, calcium, phosphorus, copper, vitamins A, B and C, α-tocopherol, riboflavin, nicotinic acid, folic acid, pyridoxine, β-carotene, protein, and in particular essential amino acids such as methionine, cystine, tryptophan and lysine present in *Moringa* leaves and pods make it a virtually ideal dietary supplement [13].

The composition of the sterols of *Moringa* seed oil mainly consists of campesterol, stigmasterol, β-sitosterol, Δ5-avenasterol and clerosterol accompanied by minute amounts of 24methylenecholesterol, Δ7-campestanol, stigmastanol and 28-isoavenasterol. The sterol composition of the major fractions of *Moringa* seed oil differs greatly from those of most of the conventional edible oils. The fatty acid composition of *M. oleifera* seed oil reveals that it falls in the category of high-oleic oils (C18:1, 67.90%–76.00%). Among the other component fatty acids C16:0 (6.04%– 7.80%), C18:0 (4.14%–7.60%), C20:0 (2.76%–4.00%), and C22:0 (5.00%–6.73%) are important. *Moringa oleifera* is also a good source of different tocopherols (α-, γ□- and δ□-); the concentration of those is reported to be 98.82–134.42, 27.90–93.70, and 48.00– 71.16 mg/kg, respectively [14].

Medicinal uses and pharmacological properties

Moringa oleifera also has numerous medicinal uses, which have long been recognized in the Ayurvedic and Unani systems of medicine. The medicinal attributes **(Table 1)** and pharmacological activities ascribed to various parts of *Moringa* are detailed below.

Antihypertensive, diuretic and cholesterol lowering activities

The widespread combination of diuretic along with lipid and blood pressure lowering constituents make this plant highly useful in cardiovascular disorders. *Moringa* leaf juice is known to have a stabilizing effect on blood pressure (2). Nitrile, mustard oil glycosides and thiocarbamate glycosides have been isolated from *Moringa* leaves, which were found to be responsible for the blood pressure lowering effect. Most of these compounds, bearing thiocarbamate, carbamate or nitrile groups, are fully acetylated glycosides, which are very rare in nature. Bioassay guided fractionation of the active ethanol extract of *Moringa* leaves led to the isolation of four pure compounds, niazinin A [1], niazinin [1] B, niazimicin [4] and niazinin A □□B which showed a blood pressure lowering effect in rats mediated possibly through a calcium antagonist effect [10,11,15].

Another study on the ethanol and aqueous extracts of whole pods and its parts, i.e. coat, pulp and seed revealed that the blood pressure lowering effect of seed was more pronounced with comparable results in both ethanol and water extracts indicating that the activity is widely distributed. Activity-directed fractionation of the ethanol extract of pods of *M. oleifera* has led to the isolation of thiocarbamate and isothiocyanate glycosides which are known to be the hypotensive principles. Methyl *p*-hydroxybenzoate and β-sitosterol [14], investigated in the pods of *M. oleifera* have also shown promising hypotensive activity. *Moringa* roots, leaves, flowers, gum and the aqueous infusion of seeds have been found to possess diuretic activity and such diuretic components are likely to play a complementary role in the overall blood pressure lowering effect of this plant [11, 16].

The crude extract of *Moringa* leaves has a significant cholesterol lowering action in the serum of high fat diet fed rats which might be attributed to the presence of a bioactive phytoconstituent, i.e. β-sitosterol. *Moringa* fruit has been found to lower the serum cholesterol, phospholipids, triglycerides, low density lipoprotein (LDL), very low density lipoprotein (VLDL) cholesterol to phospholipid ratio, atherogenic index lipid and reduced the lipid profile of liver, heart and aorta in hypercholesteremic rabbits and increased the excretion of fecal cholesterol [17].

Antispasmodic, antiulcer and hepatoprotective activities

M. oleifera roots have been reported to possess antispasmodic activity. *Moringa* leaves have been extensively studied pharmacologically and it has been found that the ethanol extract and its constituents exhibit antispasmodic effects possibly through calcium channel blockade. The antispasmodic activity of the ethanol extract of *M. oleifera* leaves has been attributed to the presence of 4-[α-(L-rhamnosyloxy) benzyl]- o-methyl thiocarbamate [3] (*trans*), which forms the basis for its traditional use in diarrhea. Moreover, spasmolytic activity exhibited by different constituents provides pharmacological basis for the traditional uses of this plant in gastrointestinal motility disorder [18].

The methanol fraction of *M. oleifera* leaf extract showed antiulcerogenic and hepatoprotective effects in rats. Aqueous leaf extracts also showed antiulcer effect indicating that the antiulcer component is widely distributed in this plant [19].

Moringa roots have also been reported to possess hepatoprotective activity. The aqueous and alcohol extracts from *Moringa* flowers were also found to have a significant hepatoprotective effect [21], which may be due to the presence of quercetin, a well known flavonoid with hepatoprotective activity [20].

Antibacterial and antifungal activities

Moringa roots have antibacterial activity and are reported to be rich in antimicrobial agents. These are reported to contain an active antibiotic principle, pterygospermin [8], which has powerful antibacterial and fungicidal effects. A similar compound is found to be responsible for the antibacterial and fungicidal effects of its flowers [22]. The root extract also possesses antimicrobial activity attributed to the presence of 4-α-L-rhamnosyloxy benzyl isothiocyanate [3, 23].

The aglycone of deoxy-niazimicine (N-benzyl, S-ethyl thioformate) [7] isolated from the chloroform fraction of an ethanol extract of the root bark was found to be responsible for the antibacterial and antifungal activities. The bark extract has been shown to possess antifungal activity [24], while the juice from the stem bark showed antibacterial effect against *Staphylococcus aureus* [17]. The fresh leaf juice was found to inhibit the growth of microorganisms (*Pseudomonas aeruginosa* and *Staphylococcus aureus*), pathogenic to man [25].

Antitumor, anticancer and antiinflammatory activities

Moringa leaves to be a potential source for antitumor activity. *O*-Ethyl- 4-(α-L-rhamnosyloxy)benzyl carbamate [11] together with 4(α-L-rhamnosyloxy)-benzyl isothiocyanate [3], niazimicin [4] and 3-*O*-(6′-*O*-oleoyl-β-D glucopyranosyl)- β-sitosterol [15] have been tested for their potential antitumor promoting activity using an *in vitro* assay which showed significant inhibitory effects on Epstein– Barr virus-early antigen. Niazimicin has been proposed to be a potent chemo preventive agent in chemical carcinogenesis [12].

The seed extracts have also been found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice. A seed ointment had a similar effect to neomycin against *Staphylococcus aureus pyodermia* in mice. It has been found that niaziminin [9 10], a thiocarbamate from the leaves of *M. oleifera*, exhibits inhibition of tumor-promoter-induced Epstein–Barr virus activation. On the other hand, among the isothiocyanates, naturally occurring 4-[(4′-*O*-acetyl-α-i-rhamnosyloxy) benzyl] [2], significantly inhibited tumor-promoter induced Epstein–Barr virus activation, suggesting that the isothiocyano group is a critical structural factor for activity [26].

The crude ethanol extract of dried seeds inhibited the carrageenan-induced inflammation in the hind paw of mice. The hexane fractions of the crude ethanol extract of the dried seeds also inhibited inflammation, and both butanol and water fractions inhibited inflammation. On the other hand, the ethyl acetate fraction caused an increase in inflammation and exhibited toxicity. The mice died after oral administration of the fraction. The crude ethanol extract also inhibited the formation of Epstein-Barr virus-early antigen (EBV-EA) induced by 12-0-tetradecanoylphorbol-13-acetate (TPA) suggesting its antitumor-promoting activity [31].

Other diverse activities

Moringa oleifera has also been reported to exhibit other diverse activities. Aqueous leaf extracts

regulate thyroid hormone and can be used to treat hyperthyroidism and exhibit an antioxidant effect. A methanol extract of *M. oleifera* leaves conferred significant radiation protection to the bone marrow chromosomes in mice. *Moringa* leaves are effective for the regulation of thyroid hormone status [27]. A recent report showed that *M. oleifera* leaf may be applicable as a prophylactic or therapeutic anti-HSV (Herpes simplex virus type 1) medicine and may be effective against the acyclovir-resistant variant. **Table 1** depicts some common medicinal uses of different parts of this plant. The flowers and leaves also are considered to be of high medicinal value with antihelmintic activity which is comparable with that of piperazine citrate [28, 35].

Moringa oleifera is coming to the forefront as a result of scientific evidence that *Moringa* is an important source of naturally occurring phytochemicals and this provides a basis for future viable developments. Different parts of *M. oleifera* are also incorporated in various marketed health formulations, such as Rumalaya and Septilin (the Himalaya Drug Company, Bangalore, India), Orthoherb (Walter Bushnell Ltd, Mumbai, India), Kupid Fort (Pharma Products Pvt. Ltd, Thayavur, India) and Livospin (Herbals APS Pvt. Ltd, Patna, India), which are reputed as remedies available for a variety of human health disorders [17].

Moringa seeds have specific protein fractions for skin and hair care. Two new active components for the cosmetic industry have been extracted from oil cake. Purisoft consists of peptides of the *Moringa* seed. It protects the human skin from environmental influences and combats premature skin aging. With dual activity, antipollution and conditioning/strengthening of hair, the *M. oleifera* seed extract is a globally acceptable innovative solution for hair care [36].

The study conducted in India reported that ethanolic and ethyl acetate seed extracts of *Moringa oleifera* exhibited significant antipyretic activity. Ethyl acetate extract also showed significant percent closure of excision wound. The healing of wounds in case of rats treated with ethyl acetate extract was found to be quicker than the control, which is also comparable with standard(vicco turmeric)[32].

Comparative Effects of Moringa Oleifera Lam. Tea on Normal and Hyperglycemic Patients conducted in Philippines showed that blood sugar levels of people in the normal group were not significantly changed 2 hours after taking the tea. However, for hyperglycemic individuals, the blood sugar levels significantly dropped after 2 hours. A mean drop of 28.15 mg/dl in the blood sugar levels was observed among the hyperglycemic patients. The results point to the benefit of using Moringa oleifera Lam. tea in the management of hyperglycemia [33].

The methanol and water extracts of M. oleifera leaf and root inhibited the 6-hydroxylation of testosterone by CYP3A4 present in human liver microsomes. Activity decreased with increasing inhibitor concentration. The estimated IC50 values are 0.5 and 2.5 mg/ml for methanol and water leaf extracts, respectively. The human CYP3A4 inhibitory activity exhibited in vitro makes Moringa a potential risk for herb/ARV interactions for individuals in HAART [34].

WATER PURIFYING ATTRIBUTES OF *M. OLEIFERA* SEED

Moringa seeds as coagulant

Moringa seeds are one of the best natural coagulants discovered so far. Crushed seeds are a viable replacement of synthetic coagulants. In Sudan, seed crude extract is used instead of alum by rural women to treat the highly turbid Nile water because of a traditional fear of alum causing gastrointestinal disturbances and Alzheimer's disease. *Moringa* seeds are very effective for high turbidity water and show similar coagulation effects to alum [29, 30]. The coagulation effectiveness of *M. oleifera* varies depending on the initial turbidity and it has been reported that *M. oleifera* could reduce turbidity by between 92% and 99% [29]. *Moringa* seeds also have softening properties in addition to being a pH correctant (alkalinity reduction), as well as exhibiting a natural buffering capacity, which could handle moderately high to high alkaline surface and ground waters. The *Moringa* seeds can also be used as an antiseptic in the treatment of drinking water. Ongoing research is attempting to characterize and purify the coagulant components of *Moringa* seeds [7, 29]. It is believed that the seed is an organic natural polymer. The active ingredients are dimeric

proteins with a molecular weight of about 1300 Da and an iso-electric point between 10 and 11 [29].

The protein powder is stable and totally soluble in water. *Moringa* coagulant protein can be extracted by water or salt solution (commonly NaCl). The amount and effectiveness of the coagulant protein from salt and water extraction methods vary significantly. In crude form, the salt extract shows a better coagulation performance than the corresponding water extract (30). This may be explained by the presence of a higher amount of soluble protein due to the salting-in phenomenon. However, purification of the *M. oleifera* coagulant protein from the crude salt extract may not be technically and economically feasible.

The coagulation mechanism of the *M. oleifera* coagulant protein has been explained in different ways. It has been described as adsorption and charge neutralization and inter-particle bridging [30]. Flocculation by inter-particle bridging is mainly characteristic of high molecular weight polyelectrolytes. Due to the small size of the *M. oleifera* coagulant protein (6.5–13 kDa), a bridging effect may not be considered as the likely coagulation mechanism. The high positive charge (pI above 10) and small size may suggest that the main destabilization mechanism could be adsorption and charge neutralization.

Microbial elimination with *Moringa* seeds

Moringa seeds also possess antimicrobial properties. It was reported that a recombinant protein in the seed is able to flocculate Gram-positive and Gram-negative bacteria cells. In this case, microorganisms can be removed by settling in the same manner as the removal of colloids in properly coagulated and flocculated water. On the other hand, the seeds may also act directly upon microorganisms and result in growth inhibition. Antimicrobial peptides are thought to act by disrupting the cell membrane or by inhibiting essential enzymes. *Moringa* seeds could inhibit the replication of bacteriophages. The antimicrobial effects of the seeds are attributed to the compound 4(α-L-rhamnosyloxy) benzyl isothiocynate [23, 30].

***Moringa* seeds as biosorbent**

Moringa seeds could be used as a less expensive biosorbent for the removal of cadmium (Cd) from aqueous media. The aqueous solution of *Moringa* seed is a heterogeneous complex mixture having various functional groups, mainly low molecular weight organic acids (amino acids). These amino acids have been found to constitute a physiologically active group of binding agents, working even at a low concentration, which because of the ability to interact with metal ions is likely to increase the sorption of metal ions. The proteineous amino acids have a variety of structurally related pH dependent properties, generating a negatively charged atmosphere and play an important role in the binding of metals [37].

FUTURE PROSPECTS

So far numerous studies have been conducted on different parts of *M. oleifera*, but there is a dire need to isolate and identify new compounds from different parts of the tree, which have possible antitumor promoters as well as inhibitory properties. Although preliminary studies are under way in different laboratories to use the antispasmodic, anti-inflammatory, antihypertensive and diuretic activities of *M. oleifera* seed, these studies should be extended to humans in view of the edible nature of the plant. *Moringa* roots and leaves have been used traditionally to treat constipation. Studies to verify these claims need to be carried out in the light of the reported antispasmodic activities, which are contrary to its medicinal use as a gut motility stimulant. Earlier studies on the presence of a combination of spasmogenic and spasmolytic constituents in different plants used for constipation might be of some guidance in designing experiments in which the presence of antispasmodic constituents at higher doses are explained as a possible mode to offset the side-effects usually associated with high dose of laxative therapy. Similarly, the known species differences in the pharmacological actions of medicinal plants may also be taken into account when planning studies involving contradictory results. Food plants are considered relatively safe as they are likely to contain synergistic and/or side effect neutralizing combinations of activities [38].

Moringa oleifera, known to be rich in multiple medicinally active chemicals, may be a good candidate to see if it contains effect enhancing and/or side-effects neutralizing combinations. Medicinal plants are relatively rich in their contents of calcium channel blockers (CCBs) which are

known to possess a wide variety of pharmacological activities such as antihypertensive, hepatoprotective, antiulcer, antiasthmatic, antispasmodic and antidiarroeal [39] and it remains to be seen whether such activities reported to be present in *Moringa oleifera* have a direct link with the presence of CCBs. Niazimicin, a potent antitumor promoter in chemical carcinogenesis is present in the seed; its inhibitory mechanism on tumor proliferation can be investigated by isolating more pure samples. The mechanism of action of *M. oleifera* as prophylactic or therapeutic anti- HSV medicines for the treatment of HSV-1 infection also needs to be examined.

The available information on the α-, δ- and γ-tocopherol content in samples of various parts of this edible plant is very limited. β-Carotene and vitamins A and C present in *M. oleifera*, serve as an explanation for their mode of action in the induction of antioxidant profiles, however, the exact mechanism is yet to be elucidated. β-Carotene of *M. oleifera* leaves exerts a more significant protective activity than silymarin against antitubercular induced toxicity. It would be interesting to see if it also possesses hepatoprotective effect against other commonly used hepatotoxic agents such as CCl4 and galactosamine, which are considered more suitable models and close to human viral hepatitis [40].

Although *Moringa* leaves are considered a best protein source, it still has to be shown whether or not this protein source could compete with the more common Protein sources in highly productive growing or milk producing ruminants. Many studies have also been conducted on the performance of *Moringa* seeds as an alternative coagulant, coagulant aid and in conjunction with alum for treating waste water. Therefore, it is important to identify the active constituents of *Moringa* seed for a better understanding of the coagulation mechanism. Reports on the antimicrobial effects of the protein purified from *M. oleifera* are very rare. Since this plant naturally occurs in varying habitats, it is naïve to expect a great magnitude of variation in the concentration and composition of chemical ingredients in different parts of the tree. However, the extent to which the chemical composition varies in populations adapted to varying habitats is not known. Thus, detailed studies are required to examine this aspect. In view of its multiple uses, the *M. oleifera* plant needs to be widely cultivated in most of the areas where climatic conditions favor its optimum growth. In this way, a maximum yield of its different useable parts could be achieved to derive the maximal amount of commodities of a multifarious nature for the welfare of mankind [41].

CONCLUSSION AND RECOMMENDATION:

Moringa oleifera is a dicotyledonous which can grow in tropical and subtropical area. Phytochemically *Moringa oleifera* contains proteins, carbohydrates, tannins, glycosides, Fatty acids, flavonoids, and carotenoids. *Moringa oleifera* has both nutritional and multimedicinal activity. Some of medicinal effects includes antimicrobial, antifungal, antihypertensive, antihyperlipidemic, antihyperglycemic, antipyretic, wound healing, antitumor, anticancer, antiinflammatory and for purification of water. Since *Moringa oleifera* can survive drought condition and its diet content is superior to vitamins and even than milk in protein content its nutritional benefit is indivisible.

However, more rigorous study is required in order to achieve a level of proof required for full biomedical endorsement of *Moringa oleifera*. Finally I strongly recommend a lot to do with Moringa species indigenous to Ethiopia which is called Moringa stenopetala for activities mentioned for *Moringa oleifera*.

REFERENCES:

1 Nadkarni AK. 1976. Indian Materia Medica. Popular Prakashan: Bombay, 810–816.
2 The Wealth of India (A Dictionary of Indian Raw Materials and Industrial Products). 1962. Raw Materials, Vol. VI: L-M; Council of Scientific and Industrial Research: New Delhi, 425– 429.
3 Palada MC, Changl LC. 2003. Suggested cultural practices fo Moringa. International Cooperators' Guide AVRDC. AVRD pub # 03–545 www.avrdc.org.
4 Dillard CJ, German JB. 2000. Phytochemicals: nutraceuticals and human health: A review. J Sci Food Agric 80: 1744–1756.
5 Estrella MCP, Mantaring JBV, David GZ. 2000. A double blind, randomised controlled trial on the use of malunggay (Moringa
oleifera) for augmentation of the volume of breast milk among non-nursing mothers of preterm infants. Philipp J Pediatr 49: 3–6.

6 Siddhuraju P, Becker K. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different
Agro-climatic origins of drumstick tree (Moringa oleifera Lam.). J Agric Food Chem 15: 2144–2155.

7 Ndabigengesere A, Narasiah KS. 1998. Quality of water treated by coagulation using Moringa oleifera seeds. Water Res 32:781–791.

8 Fahey JW, Zalcmann AT, Talalay P. 2001. The chemical diversi and distribution of glucosinolates and isothiocyanates among
plants. Phytochemistry 56: 5–51.

9 Kerharo PJ. 1969. Un remede populaire Sengalais: Le 'Nebreday'(Moringa oleifera lann.) employs therapeutiques en milieu Africain chimie et pharmacologie. Plantes Med Phytother 3:14–219.

10 Faizi S, Siddiqui B, Saleem R, Saddiqui S, Aftab K. 1994a.lation and structure elucidation of new nitrile and mustard oil glycosides from Moringa oleifera and their effect on blood presure. J Nat Prod 57: 1256–1261.

11 Faizi S, Siddiqui BS, Saleem R, Aftab K, Shaheen F, Gilani AH.1998. Hypotensive constituents from the pods of Moringa oleifera. Planta Med 64: 225–228.

12 Guevara AP, Vargas C, Sakurai H et al. 1999. An antitumor promoter from Moringa oleifera Lam. Mutat Res 440: 181– 188.

13 Makkar HPS, Becker K. 1996. Nutritional value and antinutritional components of whole and ethanol extracted Moringa oleifera leaves. Anim Feed Sci Technol 63: 211–228.

14 Anwar F, Bhanger MI. 2003. Analytical characterization of Moringa oleifera seed oil grown in temperate regions of Pakistan. J Agric Food Chem 51: 6558–6563.

15 Faizi S, Siddiqui B, Saleem R, Siddiqui S, Aftab K, Gilani A. 1994b. Novel hypotensive agents, niazimin A, niazimin B, niazicin A and niazicin B from Moringa oleifera; Isolation of first naturally occurring carbamates. J Chem Soc Perkin Trans I: 3035–3640.

16 Faizi S, Siddiqui BS, Saleem R, Siddiqui S, Aftab K, Gilani AH. 1995. Fully acetylated carbamate and hypotensive thiocarbamate glycosides from Moringa oleifera. Phytochemistry 38: 957–963.

17 Mehta LK, Balaraman R, Amin AH, Bafna PA, Gulati OD. 2003. Effect of fruits of Moringa oleifera on the lipid profile of normal and hypercholesterolaemic rabbits. J Ethnopharmaco l86: 191–195.

18 Gilani AH, Aftab K, Suria A et al. 1994a. Pharmacological studies on hypotensive and spasmodic activities of pure compounds from Moringa oleifera. Phytother Res 8: 87–91.

19 Pal SK, Mukherjee PK, Saha BP. 1995a. Studies on the antiulcer activity of Moringa oleifera leaf extract on gastric ulcer models in rats. Phytother Res 9: 463–465.

20 Gilani AH, Janbaz KH, Shah BH. 1997. Quercetin exhibits hepatoprotective activity in rats. Biochem Soc Trans 25: 85.

21 Ruckmani K, Kavimani S, Anandan R, Jaykar B. 1998. Effect of Moringa oleifera Lam on paracetamol-induced hepatotoxicity Indian J Pharm Sci 60: 33–35.

22 Das BR, Kurup PA, Rao PL, Narasimha Rao PL. 1957. Antibiotic principle from Moringa pterygosperma. VII. Antibacterial activity and chemical structure of compounds related to pterygospermin. Indian J Med Res 45: 191–196.

23 Eilert U, Wolters B, Nadrtedt A. 1981. The antibiotic principle of seeds of Moringa oleifera and Moringa stenopetala. Planta Med 42: 55–61.

24 Bhatnagar SS, Santapau H, Desai JDH, Yellore S, Rao TNS.1961. Biological activity of Indian medicinal plants. Part 1.Antibacterial, antitubercular and antifungal action. Indian JMed Res 49: 799–805.

25 Caceres A, Cabrera O, Morales O, Mollinedo P, Mendia P. 1991.Pharmacological properties of Moringa oleifera. 1: Preliminary screening for antimicrobial activity. J Ethnopharmacol 33: 213– 216.

26 Caceres A, Lopez S. 1991. Pharmacologic properties of Moringa oleifera: 3: Effect of seed extracts in the treatment of experimental Pyodermia. Fitoterapia 62: 449–450.

27 Tahiliani P, Kar A. 2000. Role of Moringa oleifera leaf extract in the regulation of thyroid hormone status in adult male and female rats. Pharmacol Res 41: 319–323.

28 Trapti R, Vijay B, Komal , Aswar P, and Khadabadi S. Comparative Studies on Anthelmintic Activity of *Moringa Oleifera* and *Vitex Negundo. Asian J. Research Chem. 2(2): April.-June, 2009*

29 Muyibi SA, Evison LM. 1995b. Optimizing physical parameters affecting coagulation of turbid water with Moringa oleifera seeds. Water Res 29: 2689–2695.

30 Francis K and Amos B. Effectiveness of *Moringa oleifera* seed as coagulant for water purification. African Journal of Agricultural Research Vol. 4 (1), pp. 119-123, February 2009

31 Amelia P. Guevara, Carolyn V, and Milagros U. Anti-inflammatory and Antitumor Activities of Seeds Extracts of Malunggay, Moringa oleifera. http://www.stii.dost.gov

32 Hukkeri V, Nagathan C, Karadi R and Patil B. Antipyretic and Wound Healing Activities of Moringa oleifera Lam. in Rats. http:// www.ijpsonline.com

33 Michael P and Howell H. Comparative Effects of Moringa Oleifera Tea on Normal and Hyperglycemic Patients. http://www.ehealthinternational.org/

34 Monera1 G, et al. *Moringa oleifera* leaf extracts inhibit 6β-hydroxylation of testosterone by CYP3A4. *J Infect Developing Countries* 2(5): 379-383; 2008.

35 Bhattacharya SB, Das AK, Banerji N. 1982. Chemical investigations on the gum exudates from Sonja (Moringa oleifera). Carbohydr Res 102: 253–262.

36 Stussi IA, Freis O, Moser P, Pauly G. 2002. Laboratories SérobiologiquesPulnoy,Francehttp://www.laboratoiresserobiologiques.com

37 Sharma P, Kumari P, Srivastava MM, Srivastava S. 2006.Removal of cadmium from aqueous system by shelled Moringa oleifera Lam. Seed powder. Bioresour Technol 97: 299–305.

38 Gilani AH, Bashir S, Janbaz KH, Shah AJ. 2005a. Presence of cholinergic and calcium channel blocking activities explains the traditional use of Hibiscus rosasinensis in constipation and diarrhea. J Ethnopharmacol 102: 289–294.

39 Stephens RL Jr, Rahwan RG. 1992. Antiulcer activity of the calcium antagonist propyl-methyleneiodioxyindene-V, localization of site of action. Gen Pharmacol 23: 193–196.

40 Gilani AH, Janbaz KH. 1995. Preventive and curative effects of Berberis aristata fruit extract on paracetamol and CCl4-induced hepatotoxicity. Phytother Res 9: 489–494.

41 Farooq A, Sajid L, Muhammad A and Anwarul H. *Moringa oleifera*: A Food Plant with Multiple Medicinal Uses. *Phytother. Res.* 21, 17–25 (2007)

How to cite this article:
Toma A. and Deyno S.: Photochemistry and pharmacological activities of *moringa oleifera*. *Int J Pharmacognosy* 2014; 1(4) 222-31: .doi: 10.13040/IJPSR. 0975-8232.1(4). 222-31.