

A Review on Pharmacological and Phytochemistry of Leaves of *Moringa Oleifera*

Megha Yadav* Amrita Mishra
Pharmacy Academy, IFTM University, Moradabad, Uttar Pradesh
*Lav4pharma@gmail.com

ABSTRACT:

Moringa oleifera, native to India, grows in the tropical and subtropical regions of the world commonly known as ‘drum stick tree’ or ‘horse radish tree’. *Moringa* can withstand both severe rough and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. *M.oleifera* seed, a natural coagulant is extensively used in water treatment. The scientific effort of this research provides insights on the use of moringa as a cure for diabetes and cancer and fortification of moringa in commercial products. This review provides an updated data on the use of *moringa* across disciplines for its medicinal value and deals with cultivation, nutrition, commercial and prominent pharmacological properties of this “Miracle Tree”.

KEYWORDS: *Moringa oleifera*, miracle tree, Nutritional value, medicinal properties.

INTRODUCTION:

Taxonomic position

Moringa is the only genus in the family *Moringaceae* and *Moringa oleifera* is the most extensively studied and cultivated species.

Kingdom -Plantae
Super kingdom -Tracheobionta
Super division -Spermatophyta
Division - Magnoliophyta
Class -Magnoliopsida
Subclass -Dilleniidae
Order -Capparales
Family -Moringaceae
Genus -*Moringa*
Species -*oleifera*

MORPHOLOGY

Moringa oleifera is a small, fast-growing ever green or deciduous tree that usually grows up to 10- or 12-m height. It has a spreading, open crown of drooping, fragile branches, feathery foliage of tripinnate leaves, and thick, corky, whitish bark [10].

Leaves-

The leaves are bipinnate or more commonly tripinnate, up to 45 cm long. These are compound leaves with leaflets of 1–2 cm long. The leaflets are finely hairy, green and almost hairless on the upper surface, paler and hairless beneath, with red-tinged midveins, with entire (not toothed) margins, and are rounded or blunt-pointed at the apex and short-pointed at the base (aestivation is opposite). The twigs are finely hairy and green, becoming brown [6,11].

Flowers-The fragrant, bisexual, yellowish white flowers are borne on slender, hairy stalks in spreading or drooping axillary clusters (panicles) 10–25cm long. Individual flowers are approximately 0.7 to 1cm long and 2cm broad, with five unequal yellowish-white, thinly veined, spatulate petals, five stamens with five smaller sterile stamens (staminodes) and a pistil composed of a 1-celled ovary and slender style [6, 11].

Fruits-Fruits are tri-lobed capsules and are frequently referred to as pods. Pods are pendulous, brown, triangular, and so splits into three parts (length wise) when dry, 30–120cm long, 1.8 cm wide. Fruits production mainly occurs in March and April. Each fruit contain around 26 seeds during their development phase. Immature pods are green in color. They turn brown on maturity and split open longitudinally [6,11].

Bark and Wood- The bark is whitish-gray, thick, soft, fissured and warty or corky, becoming rough. When wounded, the bark exudes a gum which is initially white in color but change store dish brown or brownish black on exposure. The wood is soft and light [6].

Nutritional value of *M.oleifera*

Moringa trees are used to overcome malnutrition, especially in infants and nursing mothers. Three non-governmental organizations in particular-Trees for Life, Church World Service an Educational Concerns for Hunger Organization have advocated *Moringa* as natural nutrition for the tropics. *M.oleifera* leaves have essential amino acids, including the sulfur-containing amino acids in higher levels than those recommended by the Food and Agriculture Organization (FAO) and patterns similar to those of soybean seeds. An overview on nutritional content medicinal properties is represented in Table 1 and2.

Table.1: Amino acid content of *M.oleifera*

Amino acid	Extracted leaves		Unextracted leaves	
	(g/16gN)	(g/kgDM)	(g/16gN)	(g/kgDM)
Lysine	6.61	26.77	5.6	14.06
Leucine	9.86	42.89	8.70	21.84
Isoleucine	5.18	22.53	4.50	11.30
Methionine	2.06	8.96	1.98	4.97
Cystine	1.19	5.18	1.35	3.39
Phenylalanine	6.24	27.14	6.18	15.51
Tyrosine	4.34	18.88	3.87	9.71
Valine	6.34	27.58	5.68	14.26
Histidine	3.12	13.57	2.99	7.50
Threonine	5.05	21.97	4.66	11.70
Serine	4.78	20.79	4.12	10.34
GlutamicAcid	11.69	50.85	10.22	25.65
AsparticAcid	10.60	46.11	8.83	22.16
Proline	5.92	25.75	5.43	13.63
Glycine	6.12	26.62	5.47	13.73
Alanine	6.59	28.67	7.32	18.37
Arginine	6.96	30.28	6.23	15.64
Tryptophan	2.13	9.26	2.10	5.27

Where N=Natural protein, DM=Dry matter

IJSER

Table.2: Nutritional compositions and medicinal uses of different parts of Moringa.

Part	Medicinal uses	Nutritive properties	Suggestion	References
Leaves	Treatment of asthma, hyperglycemia, Dyslipidemia, flu, heart burn, syphilis, malaria, pneumonia, diarrhea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections. Also reduces blood pressure and cholesterol and acts as anticancer, antimicrobial, Antioxidant, antidiabetic and anti-atherosclerotic agents, neuroprotectant.	Fiber, proteins and minerals like Ca, Mg, P, K, Cu, Fe, and S. Vitamins like Vitamin-A (Beta- carotene), vitamin B-choline, vitamin B1-thiamine, riboflavin, nicotinic acid and ascorbic acid are present. Various amino acids like Arg, His, Lys, Trp, Phe, Thr, Leu, Met, Ile, Val are present. Phytochemicals like tannins, sterols, saponins, terpenoids, phenolics, alkaloids and flavanoids like quercetin, isoquercetin, kaempfericetin, isothiocyanates and glycoside compounds are present.	The presence of flavanoids gives leaves the antidiabetic and antioxidant properties. The isothiocyanates are anticancer agents. Flavanoids like quercetin and others are known for anti-proliferative, anticancer agent. The presence of minerals and vitamins help in boosting the immune system and cure amyriad of diseases.	[12-14] [12, 15, 16]
Seeds	Treatment of hyperthyroidism, Chron's disease, anti-herpes-simplex virus arthritis, rheumatism, gout, cramp, epilepsy and sexually transmitted diseases, can act as antimicrobial and anti-inflammatory agents.	Contains oleic acid (Ben oil), antibiotic called pterygospermin, and fatty acids like Linoleic acid, linolenic acid, behenic acid, Phytochemicals like tannins, saponin, phenolics, phytate, flavanoids, terpenoids and lectins. Apart from these, fats, fiber, proteins, minerals, vitamins like A, B, C and amino acids.	The presence of flavanoids gives its anti-inflammatory property. The antibiotic pterygospermin is responsible for antimicrobial properties. The other phytochemicals help in treating various diseases.	[16,17] [12,18]
Root bark	Root bark acts as a cardiac stimulant, anti-ulcer and anti-inflammatory agent.	Alkaloids like morphine, moriginine, minerals like calcium, magnesium and Sodium.	The alkaloid helps the bark to be antiulcer, a cardiac stimulant and helps to relax the muscles	[15,17]
Flower	Moringa flowers act as hypocholesterolemic, anti-arthritis agents can cure urinary problems and cold.	It contains calcium and potassium and amino acids. They also contain nectar.	The presence of nectar makes them viable for use by beekeepers.	
Pods	Moringa pods treat diarrhea, liver and spleen problems, and joint pain.	Rich in fiber, lipids, non- structural carbohydrates, protein and ash. Fatty acids like oleic acid, linoleic acid, palmitic acid and linolenic acid are also present	The presence of PUFA in the pods can be used in the diet of obese.	

Phytochemistry

Phytochemical analysis of *M. oleifera* has shown the presence of a range of unique compounds with several medicinal, nutraceutical and pharmaceutical properties. The ethanolic extract of leaves contain two nitrile glycosides, three mustard oil glycosides niazirin, niazirin, niaziminin A and B and 4-[(4'-o-acetyl- α -L-rhamnosyloxy) benzyl] isothiocyanate [19]. They also contain 4-(α -L-rhamnopyranosyloxy)-benzyl glucosinolate and three monoacetyl-isomers of glucosinolate. Quercetin which is one of the most biologically active flavonoids is found as quercetin-3-o glucoside and quercetin-3-o-(6-malonyl-glucoside). It acts as a potent polyphenol antioxidant and immune system modulator. Its immune support attributes are enhanced by its synergistic association with vitamin C. Quercetin is the natural compound that assists optimal bone health, scavenge free radicals in the body which damage cell membranes, alter the DNA, and even cause cell death. Quercetin appears to protect against the damage caused by LDL cholesterol and may help prevent death from heart disease. By its anti-inflammatory action it helps to stabilize the cells that release histamine in the body. They also contain 3-caffeoylquinic acid, 5-caffeoylquinic acid and kaemferol is found as Kaemferol-3-o-(6"-malonyl-glucoside [20]. The caffeoylquinic acid has anti-hypertensive and anti-cancer properties while kaemferol exhibits anti-diabetic, anti-bacterial, anti-viral anti-cancer and cardio-protective properties. Moringa stem is a source of vanillin, 4-hydroxymellein, β -sitosterol, β -sitosterone and octanoic acid and the bark contains 4-(α -L-rhamnopyranosyloxy)-benzylglucosinolate [20]. The xudates (gum) of Moringa plant contain D-mannose, D-xylose, D-galactose, D-glucuronic acid, L-arabinose and L-rhamnose. A new compound (leucoanthocyanin) leucodelphinidin-3-o- β -D-galactopyranosyl (1-4)-o- β -D-glucopyranoside, has been reported in gum [21]. The roots of *M. oleifera* have high concentrations of both 4-(α -L-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate which are supposed to possess anti-cancer properties [20].

The extracts of the flowers contain D-glucose and D-mannose in the ratio of 5:1 along with proteins and ascorbic acid. They also contain polysaccharides which on hydrolysis give D-glucuronic acid, D-glucose, and D-galactose in a molar ratio of 0.9: 1:1.9 [22]. The pods contain nitriles, isothiocyanate compound, thiocarbamates, β -sitosterol, o-[2'-hydroxy-3'-(2"-heptenyloxy)] propylundecanoate, o-ethyl-4-[(α -1-rhamnosyloxy)-benzyl] carbamate and methyl-p-hydroxybenzoate [19, 23]. The mucilage from pods contains sugars (galactose, dextrose, xylose) a mineral (sodium, potassium, magnesium, calcium) salts of glucouronic acid [8]. The mature seeds contain 211.2 g carbohydrate, 412.0 g crude fat, 332.5g crude protein, and 44.3 g. as per kilogram dry matter. Although the essential amino acids lysine, threonine and valine are not adequately present. But, the methionine + cysteine content (43.6g/kg protein) is exceptionally high which is similar to that of chicken egg, human and

cow-milk [24]. Seeds do have elevated concentrations of both benzylglucosinolate and 4-(α -L-rhamnopyranosyloxy)-benzylglucosinol at which have potential action against cancers [23]. *M. oleifera* seeds hold 38.16% oil which further contains 0.01% Vitamin E and 0.014% beta carotene, a precursor of vitamin A [25] Moringyne (C₁₅H₂₀O₇), aglycoside is also found in extracts of the seeds [8]. The benzene extract of semi-dried seeds is a source of mono-palmitic and di-oleic triglyceraldehydes [8]. The hexane-extracted oil content of seeds ranged from 38.0-42.0% while the protein, fibre and ash contents were found to be 26.50-32.00%, 5.80-9.29% and 5.60-7.50%, respectively [26]. The compounds, 4 (α -L-rhamnosyloxy) benzyl isothiocyanate, 4 (α -L-rhamnosyloxy) phenyl acetonitrile and 4 (α -L-rhamnosyloxy) benzylglucosinolate (and its thermal degradation product 4(α -L rhamnosyloxy) phenyl acetonitrile have been isolated from the hot water extract of raw seeds [27]. The physical and chemical characteristics of the oil are :iodine value:68.00-71.80; refractive index (40°C): 1.4590-1.4625; density (24°C): 0.9036-0.9080 mg/ml; saponification value: 180.60-190.50 and unsaponifiable matter: 0.70-1.10%. The alpha, gamma and delta tocopherol present in the oil are 123.50-161.30mg/kg, 84.07-104.0mg/kg and 41.00-56.0mg/kg, respectively. The oil contains 78.59% appreciable levels of oleic acid, followed by 7.0% palmitic, 7.50 stearic, 5.99% behenic and 4.21% arachidic acid [28]. An overview on structures of selected reported phytoconstituents are represented in Fig.2

Medicinal properties Antimicrobial

Leaves, roots, bark and seeds of *Moringa oleifera* shown in vitro antimicrobial activity against bacteria (*Bacillus cereus*, *Candida albicans*, *Streptococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Shigella shingii*, *Shigella sonnei*, *Pseudomonas aeruginosa*, *E. coli* and *Aspergillus niger*, yeast, dermatophytes and helminthes in a disk diffusion technique. It was also reported that *Moringa oleifera* exhibit antifungal activity in both broth dilution and agar plate methods against *Trichophyton rubrum* and *T. mentagrophytes*, *Trichophyton mentagrophytes*, *Epidermophyton floccosum*, and *Microsporum canis*, *Fusarium solani* and *Rhizopus solani*. 4- (α -L-rhamnopyranosyloxy) benzyl isothiocyanate [29], 4- (α -L-rhamnopyranosyloxy) benzyl glucosinolate and Pterygospermin are the responsible chemical constituents responsible for its anti-biotic activity [30].

Anti-inflammatory activity

Methanolic extract of root bark, aqueous extract of roots, methanolic extract of leaves and flowers as well as ethanolic extract of seeds of *Moringa oleifera* has shown anti-inflammatory

activity in carrageenin induced paw edema model. Aurantiamide acetate and 1,3- dibenzyl urea, isolated from roots shown this anti- inflammatory activity so they responsible for anti-inflammatory activity of *Moringa oleifera* roots [31].

Anti-cancer activity

Various extracts of leaves and ethanolic extract of seeds of *Moringa oleifera* shows anti-tumor activity in *in-vitro* tests. Thiocarbamate and inhibitor of tumor promoter teleocidin B-4-induce Epstein- Barr virus (EBV) activation in Raji cells [31]

Antiepileptic activity

Methanolic extract of *Moringa oleifera* leaves were investigated its anti-convulsant activity using pentylenetetrazole (PTZ) and maximum electric shock (MES) on male albino mice [32].

Antiasthmatic activity

Alcoholic extracts of *Moringa oleifera* seed kernels were found spasmolytic in Acetylcholine, histamine, BaCl₂ and 5HT induced bronchospasm. In same study, it shown protection against egg albumin and compound 48/80 induced mast cell degranulation as well as pretreatment with alcoholic extract of *Moringa oleifera* seed kernel, decrease carrageenin induced paw edema [33].

Anti-diabetic activity

Aqueous extract *Moringa oleifera* leaves shows anti-diabetic activity on glucose tolerance in Goto-Kakizaki and wistar rats. This was supported by Jaiswal D et al., according whom aqueous extract of *Moringa oleifera* leaves shows antidiabetic control and thus exhibit glycemic control [34].

Antiuro lithiatic activity

The aqueous extract of bark of *Moringa oleifera* shows reduction in weight of stone produced using ethylene glycol (1%) induced urolithiasis model. It was proved that it possess both preventive and curative property in this study [35].

Diuretic activity

Hot water infusion of flowers, leaves, roots, seeds and bark of *Moringa oleifera* shows increased urine output in rats [31].

Anthelmintic activity

Ethanollic extract of *Moringa oleifera* leaves shown more anthelmintic activity against Indian earthworm *Pheritima posthuma*, compare to *Vitex negundo*. Time for paralysis and time for death of worms with *Moringa oleifera* leaves were less compared to roots of *Vitex negundo* [36]

Antiulcer activity

Aqueous extract of *Moringa oleifera* leaves exhibits antiulcer activity in various animal models on albino rats of either sex [31].

Wound healing activity- Aqueous extract of *Moringa oleifera* leaves shown wound healing property on male swiss albino mice. It significantly increases wound closure rate, skin breaking strength, granuloma breaking strength as well decrease in scar area. This was supported by Hukkeri *et al.* who investigated antipyretic and wound healing property of ethanolic and ethyl acetate extract of *Moringa oleifera* leaves [22].

Analgesic activity

Methanolic extract of *Moringa oleifera* root bark shown analgesic activity in Acetic acid induced writhing model in mice [27].

CNS activity

Treatment with *Moringa oleifera* leave extract restores mono amine levels of brain which may be useful in Alzheimer's disease. Methanolic extract of *Moringa oleifera* root bark was tested of frog and guinea pig and it shown local anaesthetic activity in both animal models [31]

Other promising uses

Biosorption and water purification

The contamination of soil and water resources with environmentally harmful chemicals is an alarming issue, for the survival of all living organisms including humans. The progress in industrialization and urbanization has exposed the natural environment to increasing levels of toxic elements, such as heavy metals. Biosorption is the removal of toxic heavy metals from waste water to enhance its quality from initial metal concentrations of 1–100 mg l⁻¹, to final concentrations of < 0.01–0.1 mg l⁻¹. The seed cake may be used for water purification purpose because it contains effective water purifying components [36]. Powdered seeds of *Moringa* contain cationic polyelectrolytes which act as a natural flocculent to clarify even the most turb water. The seed-powder joins with the solids in the water, settles down and also

removes 90–99% of bacteria contained in water. Water purification begins with flocculation, sedimentation, antibiosis and even reduction of *Schistosoma* cercariae titer. This simple technique replaces chemicals such as aluminum sulphate, which are dangerous to people and the environment and are expensive. *M. oleifera* has several advantages over commonly used coagulants which includes low operational cost, biodegradable sludge production, lower sludge volume, an unchanged pH of water [37].

Plant growth enhancer

Several lab-experimentation has shown that *Moringa* spray has marked beneficial effects on crops plants. The effects of sprays accelerated the growth of young plants that became firmer more resistant to pests and disease, longer life-span, heavier roots, stems and leaves and large fruits with increased yield (20–35%). *Moringa* fermented leaf juice was also tested for its growth promoting attributes in *Brassica oleracea* and the results were promising. There are prospects of widespread introduction and utilization of drumstick fermented leaf juice (DFLJ) by the Agriculture sector. It also implies that it may be worthwhile for small margin farmers to take up the production of drumstick fermented leaf juice for healthy cultivation and merge into the Organic Integrated Nutritional Management (OINM) programmed in India and other countries. This practice would not only alleviate plant macro and micro-nutrient deficiencies but also enrichment of soil for several crops. Introducing DFLJ as an organic nutritional source for different crops will ensure sustainable agriculture and the farmers may stop the use of expensive inorganic fertilizer [38].

Biopesticide

Biopesticides, being a promising alternative to conventional pesticides are eco-friendly, cost-effective and are ineffective to non-target organisms as birds, insects, and mammal. When used in Integrated Pest Management (IPM) programs, biopesticides can significantly reduce the use of conventional pesticides without affecting the crop yield. *Moringa* seed oil have the potential to be deployed as a biopesticide. The aqueous *Moringa* seed extract (AMSE) and leaf extracts have been reported to exhibit as insect repellent and fungicidal properties [39].

Biodiesel

Biodiesel is an alternative to petroleum-based conventional diesel fuel and is defined as the mono-alkyl esters of vegetable oils and animal fats. Biodiesel has been prepared from numerous vegetable oils, such as cottonseed, canola (rapeseed), palm, soybean, peanut and sunflower oils. The greatest potential for *M. oleifera* is currently thought to be in its cultivation for the production of biodiesel. A yield of about 20 metric tons of pods / hectare /

year is achievable for this species. This could provide 3000 and 4000 liters of biodiesel / hectare / annum. After acid pre-treatment to reduce the acid value of the *M. oleifera* oil, biodiesel is obtained by a transesterification procedure with methanol and an alkali catalyst at 60°C. The methyl ester (biodiesel) obtained from *Moringa* seed oil exhibit a high cetane number of approximately 67, one of the highest found for a biodiesel fuel. Overall, *M. oleifera* oil appears to be promising input for biodiesel [40].

Biogas

Much research on *Moringa stenopetala* has been reported for the production of Biogas. Availability of water is a prerequisite for large scale biogas production from *M. stenopetala* see cake powder. The pH of the system should be monitored very well in biogas production. The *Moringa* biogas plant can contribute to solve a waste problem for industries with organic wastes can provide cheap energy to that industry; produces a digestate that can be an excellent fertilizer, and which can be sold e.g., to farmers. Replacing chemical fertilizers with this bio fertilize will add important minerals to the soil, and there by contribute to increase the fertility of farmed land. The biogas plant reduces the percentage of methane released to the atmosphere and shall replace the use of fossil fuels. Last but not the least a biogas plant can serve the food producing industry.

***Moringa*: Tissue culture**

Although much research is going on with this “miracle tree” but its robust tissue culture protocol is yet to be discovered. The *in vitro* regeneration helps in rapid multiplication of the plant as compared to growing from seeds. The propagation of *Moringa* is found to be less due to its low seed germination, viability and lack of vegetative propagation methods. Most of the *invitro* regenerations carried out so far were from stem and very few on leaves as explants. An established *invitro* regeneration protocol shall provide a useful means of mass clonal propagation in order to meet the growing requirement of pharmaceutical industries for the manufacture of plant-based medicines. The Table 6 shows some tissue culture reports of *M. oleifera* use in

different explants and with varying success rates.

Dosage of *Moringa oleifera*

Leaf: 10–20ml. juice; Root bark: 2–5 g powder; Stem bark:

2–5g powder; Seed: 5– 10 g powder; Leaf, Flower, Fruit, Seed, Bark, root—1–3 g powder; 50
100 ml decoction

Commercial uses

Various parts of *Moringa* are used in marketed health formulations like, Rumalaya and Septinlin; Orthoherb Kupid Fort, Livospin.

FUTURE PROSPECTS:

The above-mentioned pharmacological properties and traditional uses of *Moringa oleifera* made it a true Miracle tree. Its better nutritional value proves it a better nutraceutical. Because it is edible, more research work can be done on humans so that a drug with multifarious effects will be available in the future market. Due to its higher nutritional value and wide range of pharmacological properties, India could easily fight against the problems of malnutrition, hunger, poverty, diseases as well as by exporting Ben oil, India can utilize its full benefits. So, for future prospective, *Moringa* can be included in routine diet (as done in work shop) to get its maximum benefits and to avoid several diseases as well as malnutrition

SUMMARY:

Moringa oleifera, a plant of Moringaceae family, is grown throughout Southern Asia. It's all parts are medicinally and nutritionally important, including leaves, roots, seeds, root- bark stem-bark, pods, etc. It mainly contains various glycosides of thiocarbamate and isocyanide class. Pterygospermin, moringyne, Niaziridin, 4-(α -L rhamno pyranosyloxy) benzyl isothiocyanat 4- (α -L- rhamnopyranosyloxy) benzyl glucosinolate, etc. are few of them which are isolated and therapeutically proved by scientific studies. Nutritional value of *Moringa* leaves is much more important and it is equivalent to seven oranges (vitamin C), four carrots (Vitamin A), four glasses of milk (Milk protein), etc. Traditionally it is used in many of diseases throughout world (mainly in Thai). Many of them are scientifically proved which mainly include antihypertensive, antiasthmatic, diuretic, anticancer, antibiotic, antiulcer, analgesic, CNS-depressant antiepileptic, anti-inflammatory, anthelmintic, antiurolithiatic and many more. Recently the workshops are going on highlighting the importance of *Moringa oleifera* leaves in Africa. thorough review on all these properties of *Moringa oleifera* suggests that “*Moringa oleifera* is a MIRACLETREE.”

CONCLUSION:

Moringa oleifera is a nature's gift to mankind as it is the most nutrient-rich and multipurpose plant discovered. Therefore, the production and consumption demand (agri-business) of this "green super food" has tremendously increased in the past 10 years. It has proved to be a wonder crop, in relation to health benefits and agroforestry. *M. oleifera* tree is extraordinary in that all parts of the tree are edible and is the most inexpensive and credible alternative to providing good nutrition, and a number of promising applications from biotechnological point of view. It provides a rich, rare and perfect combination of nutrients, amino acids, antioxidants, anti-aging and anti-inflammatory properties used for nutrition and healing. As the *Moringa* tree has spread from the Indian sub-continent throughout the tropical and sub-tropical world, it has adapted itself to local conditions, resulting in many variations. Thus, rigorous localized studies are needed to test the leaves' nutritional content and effects in different areas. *Moringa* leaves have been used in the traditional medicine since centuries, in many cultures. Now they have also attracted the interest of the scientific community. However, most of the studies done so far are either nutritional analyses or laboratory studies with animals. There are few studies done so far on its direct effects on human beings. Considering the potentially enormous benefits to humanity, medically controlled studies with human subjects are crucial, to determine the bio-availability and effectiveness of nutrients in *Moringa* leaves. *M.oleifera* is also a promising source of 2nd generation biodiesel and the foundation of a profitable business planning. The key challenge is to overcome the bottle necks in the business planning. It can be possible through joint efforts by the private sector, small holders, associations, larger companies and public institutions. The conservation of the *Moringa* is of immense concern from biodiversity, ethnobotanical, dietary and pharmacological perspective. The governments of all the developing countries should collectively take initiatives to uplift the rural standards by employing poor farmers under Operation Plant *Moringa Tree* (OPMT) and provide them with land and other resources. They should organize routine-workshops, assist them in harvesting and processing, and pay them according to their yield. This type of empowerment will trim down their poverty and make this 'miracle tree' to growing every house and become a part of their routine diet.

REFERENCES:

1. Newman, D.J. and G.M. Cragg, Natural products as sources of new drugs over the last 25 years. *Journal of natural products*, 2007. 70(3): p.461-477.
2. Cragg, G.M. and D.J. Newman, Plants as a source of anti-cancer agents. *Journal of ethnopharmacology*, 2005. 100(1): p.72-79.
3. Balunas, M.J. and A.D. Kinghorn, Drug discovery from medicinal plants. *Life sciences*, 2005. 78(5): p. 431-441.
4. Rates, S.M.K., Plants as source of drugs. *Toxicon*, 2001. 39(5): p.603-613.
5. Organization, W.H., *World Health Statistics Annual*. 1986: World health organization.
6. Warriar, P.K. and V. Nambiar, *Indian medicinal plants: a compendium of 500 species*. Vol. 5. 1993: Orient Black swan.
7. Mahmood, K.T., T. Mugal, and I.U. Haq, *Moringa oleifera: a natural gift-A review*. *J. Pharm. Sci. Res*, 2010. 2(11): p.775-781.
8. Fahey, J.W., *Moringa oleifera: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part 1*. *Trees for life Journal*, 2005.1(5).
9. Goyal, B.R., et al., *Phyto-pharmacology of Moringa oleifera Lam.—an overview*. 2007.
10. Anwar, F., et al., *Moringa oleifera: a food plant with multiple medicinal uses*. *Phytotherapy research*, 2007. 21(1): p.17-25.
11. Evans, W.C., *Trease and Evans' Pharmacognosy E-Book*. 2009: Elsevier Health Sciences.
12. Rockwood, J., B. Anderson, and D. Casamatta, Potential uses of *Moringa oleifera* and an examination of antibiotic efficacy conferred by *M. oleifera* seed and leaf extracts using crude extraction techniques available to underserve indigenous populations. *International Journal of Phototherapy Research*, 2013. 3(2): p.61.
13. Mbikay, M., Therapeutic potential of *Moringa oleifera* leaves in chronic hyperglycemia and dyslipidemia: a review. *Frontiers in pharmacology*, 2012.3.
14. Fuglie, L., *The Moringa Tree: a local solution to malnutrition*. Church World Service in Senegal, 2005: p.75.
15. Thurber, M.D. and J.W. Fahey, Adoption of *Moringa oleifera* to combat under-nutrition viewed through the lens of the “Diffusion of Innovations” theory. *Ecology off wood and nutrition*, 2009.48(3):p.212-225.
16. Sutalangka, C., et al., *Moringa oleifera* mitigates memory impairment and neurodegeneration in animal model of age-related dementia. *Oxidative medicine and cellular longevity*, 2013.2013.
17. Adeyemi, O. and T. Elebiyo, *Moringa oleifera* supplemented diets prevented nickel-induced nephrotoxicity in wistar rats. *Journal of nutrition and metabolism*, 2014.2014.
18. Monera, T.G. and C.C. Maponga, Prevalence and patterns of *Moringa oleifera* use

- among HIV positive patients in Zimbabwe: a cross-sectional survey. *Journal of public health in Africa*, 2012.3(1).
19. Faizi, S., et al., Fully acetylated carbamate and hypotensive thiocarbamate glycosides from *Moringa oleifera*. *Phytochemistry*, 1995. 38(4): p.957-963.
 20. Bennett, R.N., et al., Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees *Moringa oleifera* L.(horseradish tree) and *Moringa stenopetala* L. *Journal of agricultural and food chemistry* 2003. 51(12): p.3546-3553.
 21. Khare, G., V. Singh, and P. Gupta, A new leucoanthocyanin from *Moringa oleifera* gum. *Journal of the Indian Chemical Society*, 1997. 74(3): p. 247-248.
 22. Pramanik, A. and S.S. ISLAM, Chemical investigation of aqueous extract of the mature and premature flowers of *Moringa oleifera* (Sajina) and structural studies of a polysaccharide isolated from its premature flowers. *Indian journal of chemistry. Sect. B: Organic chemistry, including medical chemistry*, 1998. 37(7): p.676-682.
 23. Faizi, S., et al., Hypotensive constituents from the pods of *Moringa oleifera*. *Planta medica*, 1998. 64(03): p.225-228.
 24. Oliveira, J.T.A, et al., Compositional and nutritional attributes of seeds from the multipurpose tree *Moringa oleifera* Lamarck. *Journal of the Science of Food and Agriculture*, 1999. 79(6): p.815-820.
 25. Dahot, M. and A. Memon, Nutritive significance of oil extracted from *Moringa oleifera* seeds. *J Pharm Univ Karachi*, 1985.3.
 26. Tsaknis, J., et al., Characterization of *Moringa oleifera* variety Mbololo seed oil of Kenya. *Journal of Agricultural and food chemistry*, 1999. 47(11): p.4495-4499.
 27. Villasenor, I.M., C.Y. Lim-Sylianco, and F. Dayrit, Mutagens from roasted seeds of *Moringa oleifera*. *Mutation Research/Genetic Toxicology*, 1989. 224(2): p.209-212.
 28. Anwar, F. and M. Bhangar, Analytical characterization of *Moringa oleifera* seed oil grown in temperate regions of Pakistan. *Journal of Agricultural and food Chemistry*, 2003. 51(22): p.6558-6563.
 29. Tahiliani, P. and A. Kar, Role of *Moringa oleifera* leaf extract in the regulation of thyroid hormone status in adult male and female rats. *Pharmacological research*, 2000. 41(3): p.319-323.
 30. Anderson, D., et al., The gum exudates from *Chloroxylon swietenia*, *Sclerocaryacaffra*, *Azadirachta indica* and *Moringa oleifera*. *Phytochemistry*, 1985. 25(1): p.247-249.
 31. Mishra, G., et al., Traditional uses, phytochemistry and pharmacological properties of *Moringa oleifera* plant: An overview. *Der Pharmacia Lettre*, 2011. 3(2): p.141-164.
 32. on, P.a.p.v., *INTERNATIONAL RESEARCH JOURNAL OF PHARMACY*.
 33. Mehta, A. and B. Agrawal, Investigation into the mechanism of action of *Moringa*

- oleifera for its anti-asthmatic activity. *Orient Pharm Exp Med*, 2008. 8(1): p.24-31.
34. Ndong, M., et al Effects of oral administration of *Moringa oleifera* Lam on glucose tolerance in Goto-Kakizaki and Wistar rats. *Journal of Clinical Biochemistry and Nutrition*, 2007. 40(3): p.229-233.
35. Fahad, J.F., et al., Antiurolithiatic activity of aqueous extract of bark of *Moringa oleifera* (Lam.) in rats. *Health*, 2010. 2(4): p.352-355.
36. Trapti, R., et al., Comparative studies on anthelmintic activity of *Moringa oleifera* and *Vitex negundo*. *Asian Journal of Research in Chemistry (AJRC)*, 2009. 2(2): p.181-182.
37. Anwar, F., et al., Enhancement of the oxidative stability of some vegetable oils by blending with *Moringa oleifera* oil. *Food Chemistry*, 2007. 103(4): p.1181-1191.
38. Rajamani, R., et al., Drumstick fermented leaf juice (DFLJ)-A PROMISING ORGANIC SIGNATURE FOR TOMATO CULTIVATION PACKAGE. *Global J Res. Med. Plants & Indigen. Med.* | Volume, 2015. 4(1): p.10-19.
39. Nandave, M., et al., *Moringa oleifera* leaf extract prevents isoproterenol-induced myocardial damage in rats: evidence for antioxidant, antiperoxidative, and cardio protective intervention. *Journal of medicinal food*, 2009. 12(1): p.47-5
40. Fernandes, D.M., et al., *Moringa oleifera*: A potential source for production of biodiesel and antioxidant additives. *Fuel*, 2015. 146: p.75-80.

IJSER