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Review Article

"Miracle Tree" *Moringa oleifera* Its Nutritive Importance and Safety Efficacy

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Abstract

Moringa oleifera leaves, seeds, bark, roots, sap, and flowers are widely used in more than 80 countries to relieve mineral and vitamin deficiencies. It supports a healthy cardiovascular system, promote normal blood-glucose levels, neutralize free radicals {thereby reducing malignancy}, provide excellent support of the body's anti-inflammatory mechanisms, enrich anemic blood and support immune system. It also improves eyesight, mental alertness and bone strength. It is one of the richest plant sources of Vitamins A, B, C, D, E and K. The vital minerals present in *Moringa* include Calcium, Copper, Iron, Potassium, Magnesium, Manganese and Zinc. It has more than 40 natural anti-oxidants. *Moringa* is an edible extremely safe plant. It can be easily and cheaply cultivated. Besides, *Moringa* has a direct impact on agriculture, water, sanitation, biodiversity and environment. *Moringa* responds to environmental and financial sustainability, realism and results, innovation, biodiversity, education and awareness. A wide variety of polyphenols and phenolic acids as well as flavonoids, glucosinolates, and possibly alkaloids is extracted from its different parts and believed to be responsible for biological activities including antioxidant, tissue protective (liver, kidneys, heart, testes, and lungs), analgesic, antiulcer, antihypertensive, radio protective, and immuno modulatory actions. Standardization of products is an issue before its wide application in human beings.

Keywords: *Moringa Oleifera*; Parts; Benefits; Nutritional Value; Therapeutic Use; Safety Case.

Introduction

Mineral element deficiencies and Protein-energy malnutrition affects mostly children in poor countries (de Onis et al., 1993; Worldwatch Institute, 2011; Gonzalez 2015), with plant foods being key tools in addressing this situation. In 2011 alone, some 45% of all child deaths involved under nutrition (Black et al., 2013). Global priority is therefore to improve access to healthy food (de Onis et al., 1993). Most of the world's poor live in the tropics and of these the majority live in seasonally dry lowlands (Black et al., 2008, 2013; Sachs 2001; Food and Agriculture Organization of the United Nations, 2015). The development of plants not only with high nutrient levels but also exceptional drought resistance is essential. "Life on this planet has been likened to a pyramid with an unbelievably wide base and a small apex. Humans are somewhere near the top but not at the top because they are omnivores. They are one of those animals that can subsist on a wide range of food: vegetable and animal" (Seymour 2003). Plants have always been vital for mankind irrespective of the era and area all over the globe since the beginning of life. Edible wild indigenous plants become an alternative source for food possessing high potential of vitamins, minerals and other interesting elements particularly during seasonal food storage. Wild fruits are also known to have nutritional and medicinal properties that could be attributed to their antioxidant

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effects as well as being used to fortify stable foods particularly for malnourished children (Compaore et al., 2011).

Moringa oleifera Lam. tree grows widely in many tropical and subtropical countries. It is grown commercially in India, Africa, South and Central America, Mexico, Hawaii, and throughout Asia and Southeast Asia. It is well known vegetable in Africa, Arabia, India, Southeast Asia, America and Pakistan (Sengupta and Gupta, 1970). The genus *Moringa* have thirteen species in the world and it is a monogeneric family belonging to the Moringaceae and having two species in India viz. *M. concanensis* Nimmo ex Dalz. and Gibs. and *M. oleifera* Lam. Its roots, fruits, leaves and flowers been used as vegetables (Siddhuraju and Becker, 2003). The leaves are potential source of vitamin A and C, iron, calcium, riboflavin, β-carotene and phenolic acid (Nambiar et al., 2005). Its leaves and oil are a powerful natural antioxidant (Njoku and Adikwu, 1997). Siddhuraju and Becker (2003) observed antioxidant properties in the solvent extract of moringa leaves. Seeds, leaves, oil, sap, bark, roots, and flowers are widely used in traditional medicine. Leaves have been characterized to contain a desirable nutritional balance, containing vitamins, minerals, amino acids, and fatty acids (Moyo et al., 2011; Teixeira et al., 2014; Razis et al., 2014). Additionally, leaves reported to contain various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics, and carotenoids (Alhakmani et al., 2013; Vongsak et al., 2014). According to several authors (Anwar et al., 2007; Mbikay, 2012; Razis et al., 2014), various preparations of *M. oleifera* are used for their antiinflammatory, antihypertensive, diuretic, antimicrobial, antioxidant, antidiabetic, antihyperlipidemic, antineoplastic, antipyretic, antiulcer, cardioprotectant, and hepatoprotectant activities. The therapeutic potential of *M. oleifera* leaves in treating hyperglycemia and dyslipidemia was reviewed by Mbikay (2012). Razis et al., (2014) summarized potential health benefits of *M. oleifera*, focusing on their nutritional content as well as antioxidant and antimicrobial characteristics.

Objectives of the Study

The concept of biodiversity in the form of food based supplementation as a mechanism to possibly provide diversity to the diets of people is prominent in nutrition research on food sources available. It is a concern that the original or cultural knowledge of people concerning foods and the nutritional value thereof are being lost to diet transition with migration and urbanization (Kuhnlein, 2003). The food compositions of a diverse range of foods have been analyzed and more still have to be analyzed as initiated in FAO projects lately (FAO, 2008). Johns (2003) and Kuhnlein (2003) suggests that with the knowledge of nutritional analysis, a range of foods could be introduced to supplement the diet of a household to improve food and nutrition security. Both authors view more research on traditional foods, such as traditional leafy vegetables, and its contribution in micronutrient contents as a positive step towards health promotion or intervention strategies.

The review aims to investigate the usage of *M. oleifera* leaves in the diets of existing users and to investigate the possibility of introducing the plant to households in need of diversifying their dietary intake. Considering all the above facts the present study is being undertaken to throw light on the different aspects of this plant in this overview.

Identifying Characters of Different Parts of M. oleifera

Moringa is a fast growing tree which can reach 12 m in height at maturity. The stem of the *Moringa* tree is normally straight, but occasionally poorly formed. The tree grows with short straight stems and can reach a height of 1.5 to 2 m before it begins branching out (Rajangam et al., 2001). The branches usually grow in a disorganized manner and the canopy is umbrella-shaped. The leaves are of a compound leaf form, with three leaflets arranged on either side of the stem in pairs opposite each other, growing mostly at the branch tips. The leaves are 20 to 70 cm long with 8 to 10 pairs of pinnae, each bearing two pairs of opposite elliptic or obovate leaflets (Rajangam et al., 2001). The fruit is a green three lobed pod that hangs down from the branches and can be 20 to 60 cm in length. When dry, it opens into 3 parts. Each pod contains between 12 and 35 seeds (Rajangam et al., 2001). The seeds are round, with brownish semi–permeable seed hulls. The hull itself has three wings that run from the top to the bottom at 120 degree intervals. The average weight per seed is 0.3 g. *Moringa* can be cultivated from cuttings and from seeds.

Nutritive Value of M. oleifera

The leaves of the tree contain balanced levels of essential amino acids as well as high levels of protein, calcium, and vitamin A (Sena et al., 1998; Makkar and Becker, 1996; Freiberger et al., 1998). Consequently, the plant is used extensively for low-cost nutrition (Thurber and Fahey 2009; Zongo et al., 1991; Fahey 2005). All parts of the tree are used medicinally and appear to have potent antioxidant, cancer chemo preventive, and gluco regulatory

activity (Fahey 2005; Bennett et al., 2003; Tumer et al., 2015; Siddhuraju and Becker, 2003). The seeds yield high-oleic oil used in cooking, cosmetics, and as a machinery lubricant (Tsaknis et al., 1999; Anwar and Bhanger, 2003). After oil extraction, the remaining seed cake can be used to clarify turbid water or to increase protein in animal feed or crop fertilizer (Folkard and Sutherland, 2002; Sarwatt et al., 2002; Baptista et al., 2015). Other uses include leaf extract as a leaf-applied fertilizer (Foidl et al., 2001). Despite the clear utility of the tree, crucial information gaps impede its optimal use in all of these applications, including nutrition.

According to Fuglie (2001), *Moringa* has gained popularity as a source of nutrition that can feed the needy and save lives as well. *Moringa* leaves or leaf powder can be used successfully as a complex food to nourish small children, pregnant women and nursing mothers as a treatment for malnutrition. The abundance of vitamin A in *Moringa* can contribute to the treatment of xerophthalmia (night blindness).

Fuglie (2001) and Marcu (2005) reported that *Moringa* leaves have about 40% protein with all of the nine essential amino acids present in various amounts. Because of this, *Moringa* is considered to have the highest protein ratio of any plant studied so far. It was reported that 100 g of *Moringa* leaves contain more than 200 mg of vitamin C and a high content of vitamin A in the form of provitamin A or β-carotene (Fuglie, 2001; Marcu 2005).

Leaves and pods of *Moringa* are rich in minerals and vitamins and could potentially be used in nutritional intervention programmes as a preventive measure against malnutrition. It has been observed that the nutrient composition of traditional vegetables has been recorded using different values, and furthermore unconfirmed data has been recycled in scientific and popular publications (McBurney et al., 2004). However, the high nutritional value of *Moringa* is widely recognized. Its value as a source of vitamin A is reported by Fuglie (2001).

Ramachandran et al., (1980) reported the vitamin A content of *Moringa* as 11,300 IU per 100 g edible portion. The original source did quote the value as β-carotene, which should read 11,300 IU β-carotene per 100g edible portion (McBurney et al., 2004). Babu (2000) reported vitamin A content as 3767 IU per 100 g edible portion. A publication of Kuhnlein (2003) quoted *Moringa* in Niger as containing 5880 µg β-carotene per 100 g edible portion. This data of Kuhnlein (2003) is recommended by McBurney et al., (2004). An initiative was launched by FAO to analyze the nutrient composition of traditional leafy vegetables so as to standardize the nutrient content per 100 g edible portion (FAO, 2008).

Fuglie (2001) recommends that 25 g of *Moringa* leaf powder equals one rounded tablespoonful of *Moringa* leaf powder which when added to infants' food three times per day would provide roughly the RDA with calcium and vitamin A 1.5 mg or 1500 µg exceeding the RDA by 310%. The vitamin A intake for the group children 1-3 years in South Africa was less than one out of two 55-66% that was half the recommended level (Labadarios, 2000). The vitamin A intake for children living rural in the age groups between 1-9 years was 62-73%. At national level less than one of two 55-68% children had a vitamin A intake that was half the recommended level (Labadarios, 2000).

The leaves are the most nutritious part of the plant, being a significant source of vitamin B6, vitamin C, pro-vitamin A as β-carotene, magnesium and protein, among other nutrients (Peter 2008). When compared with common foods particularly high in certain nutrients per 100 g fresh weight, *Moringa* leaves are considerable sources of these same nutrients (Makkar and Becker, 1997; Fuglie, 2001). Scientific research confirms that leaves of this plant are of significant nutritional value. Gram for gram, *Moringa* leaves contain: seven times the vitamin C in oranges, four times the Calcium in milk, four times the vitamin A in carrots, two times the protein in milk and three times the Potassium in bananas (Hsu et al., 2006). It also contains Vitamins B1, B2, B3, B6, B7, D, E, K, and amino acids isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, alanine, asparatic acid, cysteine etc. Some of the calcium in *Moringa* leaves is bound as crystals of calcium oxalate which may inhibit calcium availability to the body (Olson and Carlquist, 2001).

Nutritional Benefits of Different Parts of M. oleifera

Leaves

Benefits

Moringa leaves are very rich source of vitamin A, C, Ca, K, protein and essential elements in comparison to locally available in market viz. Carrot, orange, cow milk, banana etc. The leaves may be supplemented as essential food. The leaves can be served to check malnutrition in the poor's. It is a nutraceutical and universal remedy for various diseases having 35 elements. Leaf powder can be used as hand washing product-hand hygiene to reduce gastrointestinal and respiratory illness. Tender twigs and immature pods used as fodder for cattle's to increase milk. Pregnant woman consumed leaves and flowers to increase milk

for infants. Leaf powder used as biocontrol in crops, as fertilizers and pesticides.

Phytochemistry

Leaves contain high iron, minerals, vitamins and proteins. It also contains 14 macroelements and 21 microelements (total 35 elements). During hand washing the mechanical friction by the dry leaf powder reduces the bacterial effect in comparison to non-medicated liquid soap (Asiedu-Gyekye et al., 2014; Anwar et al., 2007; Fozia et al., 2012; Kamal 2008; Khawaja et al., 2010; Paliwal 2011b; Paliwal 2011a; Parrotta et al., 2009; Wealth of India, 2001).

Stem

Benefits

Stem pulp used to make newspaper and textile industries. Corky bark yield fibers used in making mats, paper, cordages etc.

Phytochemistry

Presence of Cellophane (Parrotta et al., 2009; Wealth of India, 2001)

Pods

Benefits

Immature pods cooked as vegetable or pickled, having high nutritional and medicinal value.

Phytochemistry

Contains higher percentage of vitamins essential elements, glycosides etc (Parrotta et al., 2009; Wealth of India, 2001).

Seeds

Benefits

Seed powder paste used as water purifier to improve the quality of drinking water by absorbing the heavy metals viz. Cadmium, Copper, Chromium, Lead and Zinc which are highly toxic to human being. The seeds can be used as nutritional supplements for industrial and agriculture purpose. It is also being used in perfume industries, cosmetic, lubricate, soap as antioxidant activity oil used as body cream. It can also used as vegetable in daily consumption.

Phytochemistry

Moringa has cationic polyelectrolyte of short chain and low, molecular weight. Heavy metals having higher charges are trapped by seed powder. Seeds oil locally known as "*ben oil*" "*Drumsticks*" similar to olive oil and is rich in Palmetic, stearic and oleic acids. The oil is clear, odourless and resists rancidity, oil possesses 75% oleic acid and therefore used in perfume and soap industry (Ojiako and Okeke, 2013).

Chemical Composition of Different Parts of Moringa oleifera

The chemical composition of different parts of *Moringa* by Massry et al., 2013 reveals that that seeds of *M. oleifera*, as other legumes, are good sources for proteins and crude fibers. It contained 44.78, 25.97 and 4.87 % (on dry weight basis), respectively. Also, dried leaves contained high amounts of protein and crude fibers which were 26.79 and 18.67 %, respectively. Total carbohydrates contents were higher in fresh and dried leaves of *M. oleifera*, which were 37.85 and 35.90%, respectively. In addition the ash content was 3.64 and 7.92%, respectively

Mineral Contents of Different Parts of M. oleifera

M. oleifera contains different minerals. It contains high concentrations of calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K) and sodium (Na) in dried leaves than those of *Moringa* other parts. The concentrations of the aforementioned minerals were 2078.98, 346.87, 403.56, 1498.75 and 72.50 mg / 100 g (DWB) respectively. The seeds contain also the same minerals contents, which were nearly similar to those in *M. oleifera* leaves, which were, 76.85, 524.30, 259.78, 64.24 and 24.92 mg / 100 g (DWB). On the other hand, *Moringa* seeds contained appreciable amounts of minerals especially microelements such as; zinc (Zn), copper (Cu) and manganese (Mn). The values obtained for the microelements, Zn (27.47), Cu (48.13) and Mn (87.75) mg / 100 g (DWB), respectively (Massry et al., 2013).

Amino Acids of Different Parts of M. oleifera

M. oleifera contained 18 (eighteen) amino acids. Argenine, glutamic acid and cystine in *M. oleifera* seeds protein were the most predominant amino acids which contents are 12.68, 18.76 and 4.59 g/ 16 g N, respectively. On the other hand, *M. oleifera* leaves contained high amount of other amino acids, especially essential amino acids such as, methionine, valine, phenylalanine, leucine, lysine and tryptophan, which were 2.12, 6.47, 6.38, 10.12, 6.73 and 2.17 g / 16 g N, respectively (Massry et al., 2013).

Natural Antioxidants and Antioxidant Activities of M. oleifera Different Parts

Total polyphenols, total flavonoids, ascorbic acid, â-carotene, carotenoids and total antioxidant activity are found in different parts of *M. oleifera*. Total polyphenols, total flavonoids and ascorbic acid of different *Moringa* plant parts ranged from (9.57 to 22.38), (68.97 to 142.20) and (67.84 to 871.28) mg / 100 g (DWB), respectively. On the other hand, β-carotene and carotenoids ranged from (0.65 to 28.36) and (28.94 to 149.95) mg / 100 g (DWB), respectively in different *Moringa* plant parts. Total antioxidant activity also ranged from (133.78 to 168.34)%, for pods and leaves (Massry et al., 2013).

Identification of Phenolic Compounds of Different Parts of M. oleifera by HPLC Analysis

Ten phenolic compounds were identified from *Moringa* different parts by High Performance Liquid Chromatography (HPLC) analysis. The detected phenolic compounds were gallic acid, chlorogenic acid, ellagic acid, ferulic acid, kaempferol, quercetin , rutin, syringic acid, caffeic acid and catechin. The highest contents of phenolic compounds were quercetin, kaempferol and rutin for pods, seeds and fresh and dried leaves, respectively. The above mentioned values were 42.36, 74.13 and 97.68 mg/ 100g (DWB), respectively. quercetin ,caffeic acid and kaempferol were predominant phenolic compounds in *Moringa* pods and seeds extracts. Whereas, the rutin, caffeic acid and ferulic acid are the dominant phenolic constituents of *Moringa* leaves extracts (Massry et al., 2013).

Therapeutic Uses of Different Parts of M. oleifera

Phytochemicals 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. *Moringa* contains a range of fairly unique phytochemicals containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates. Six phytochemicals have been reported to have hypotensive, anticancer, and antibacterial activity include benzyl isothiocyanate , niazimicin , pterygospermin**,** benzyl isothiocyanate**,** and 4-{a-L-rhamnopyranosyloxy} benzyl glucosinolate (Costa-Lotufo et al., 2005; Fahey et al., 2004; Faizi et al., 1998; Fuglie 1999; Fuglie 2000; Fuglie 2001).

Numerous studies now point to the elevation of a variety of detoxication and antioxidant enzymes and biomarkers as a result of treatment with *Moringa* or with phytochemicals isolated from *Moringa* have shown, antiulcer, effect on immune response, spasmolytic activities, hypocholesterolemic effects, antibacterial activity. sympatholytic activity and antiviral activity against herpes simplex virus type-1 (Galan et al., 2004; Ghasi et al., 2000; Gilani et al., 1994; Hameed-Un-Nisa et al, 1998; Haristoy et al., 2005). Antioxidants play an important role in inhibiting and scavenging free radicals, thus providing protection to human against infections and degenerative diseases. The data obtained suggests that the extracts of *M. 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 (Sreelatha and Padma, 2009; Yongbai 2005).

Roots

Therapeutic uses

The roots aqueous extract and dry root powder is antilithic, rubefacient, vesicant, antispasmodic, hepatoprotective, carminative, antifertility, antiinflammatory, stimulant in paralytic condition; considered as cardiac/circulatory stimulant, laxative, abortifacient, rheumatism, joints pains, lower back pains or in renal pains. The juice of root- bark is said to very effective if put in ear and tooth cavity as a pain killer, and has antitubercular activity.

Phytochemistry

The aqueous and ethanol extract of roots having o-sito-sterol, alkaloid moringinine which act as cardiac stimulant. (Caceres et al., 1992; Dahot 1988; Duke 2001; Khare et al., 1997; Padmarao et al., 1996; Ruckmani et al., 1998).

Stem-Bark

Therapeutic Uses

The aqueous stem extract used to cure as rubefacient, vesicant, eye infections, prevent enlargement of spleen and formation of tuberculosis glands of the neck, to destroy tumours and to heal ulcers, antibacterial activity.

Phytochemistry

Contain two alkaloids namely moringine and moringinine, vanillin, â-sitosterol, â-sitostenone, 4-hydro-xymellin and octacosanoic acid have been

isolated from the stem-bark (Bhatnagar et al., 1961; Faizi, 1994a; Faizi 1994b; Ghasi et al., 2000; Kerharo 1969; Siddhuraju and Becker, 2003).

Leaves

Therapeutic uses

Leaves extracts used in malnutrition to supplement vitamins, essential elements, proteins etc., antihypertensive, diuretic, cholesterol lowering, blood pressure control, antipyretic, decrease blood glucose concentration, antidiabetic, antioxidant, hepato-protective, reduces liver fibrosis, anticancer-antitumor activities, antifertility, antispasmodic, antiulcer, gastrointestinal disorder, cardiac and circulatory stimulant, eye or ocular diseases like night blindness and ear infection, bronchitis, antiasthma, analgestic, antimicrobial, antibacterial, antifungal etc. Leaves juice applied externally to cure scurvy, sores, temples for headache, piles, sores of throat, glandular swelling, eye and ear infection, etc.

Phytochemistry

Antibacterial effect is shown due to presence of Pterygospermin. Antifungicidal effects is shown by 4 - (4'-o-acetyl – a – L - rhamnopyranosy - loxy) benzyl isothiocyanate, 4 (a – L - rhamnopyranosyloxy) benzyl isothiocyanate, nizimicin, isothiocyanate and 4 (a-L-rhamnopyranosyloxy). It also contains alkaloid Moringine-as antiasthmatic. Nitrile, mustard oil glycosides and thiocarbamate glycosides helps in lowering blood pressure. Dark chocolate polyphenols and other polyphenols have hypoglycaemic or antidiabetic effect. Quecetin and kaempferol used as antioxidant and hepatoprotective. Niazimicin has anticancer properties. The leaves act as a good source of natural antioxidant due to presence of various types of antioxidant compounds such as ascorbic acid, flavonoides, phenolics and carotenoids, other major and minor essential elements, vitamins, amino acids (Agrawal and Mehta, 2008; Al-Awwadi et al., 2004; Anwar et al., 2005; Bajpai et al., 2005; Bose 1980; Dahot, 1988; Fahey 2005; Faizi et al., 1995; Faizi et al., 1994a; Faizi et al., 1994b; Faizi et al.,1998; Anwar et al., 2007; Fozia et al., 2012; Fuglie 2001; Ghada 2013; Gilani et al., 1994; Grassi et al., 2005; Guevaraa et al., 1999; Kirtikar and Basu, 1975; Moharram et al., 2003; Makkar and Becker, 1996; Makonnean et al., 1997; Morton 1991; Nwosu and Okafor, 1995; Ojiako and Okeke, 2013; Paliwal 2011b; Paliwal 2011a; Rao et al., 1946; Ruckmani et al., 1998; Selvkumar and Natarajan 2008; Siddhuraju and Becker, 2003; Sikder et al., 2013; Trees For Life, 2005 ; Wealth of India, 2001).

Flowers

Therapeutic uses

Highly medicinal value as a stimulant, aphrodisiac, abortifacient, cholagogue, used to cure inflammations, muscle diseases, hysteria, tumours and enlargements of the spleen, useful in lowering the serum cholesterol, phospholipids, triglyceride, VLDL, LDL cholesterol to phospholipids ratio atherogenic index; decrease lipid profile of liver, heart and aorta.

Phytochemistry

Flowers contain nine amino acids, Sucrose, D-glucose, traces of alkaloids, wax, quercitin and kaempferat; the ash is rich in potassium and calcium. It also reported to contain some flavonoid pigments such as alkaloids, kaempherol rhamnetin, isoquercirin and Kaempleritrin (Bhatnagar et al., 1961; Ruckmani et al., 1998; Siddhuraju and Becker, 2003).

Seeds/pods

Therapeutic uses

The seed extract if taken orally very effective in decreasing liver lipid peroxides, antihypertensive. The seeds are antipyretic, acrid, bitter and antimicrobial activity. The seed can be consumed fresh as peas or pounded, roasted, or pressed in to sweet, non-desiccating oil, commercially known as '*Ben oil*' of high quality. ethanol and aqueous extracts of whole pods, seed-coat, pod pulp revealed that the B.P. lowering effect of seed is more pronounced.

Phytochemistry

The antihypertensive compounds thiocarbamate and isothiocyanate glycosides have been isolated from the acetate phase of the ethanolic extract of the pods. 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 as purifier. The seed oil contains sterols. The sterol composition of the major fractions of *M. oleifera* seed oil differs greatly from conventional vegetable oils. The seed oil is having high oleic acid (Anwar and Bhanger, 2003; Anwar et al., 2005; Faizi et al., 1998; Guevaraa et al., 1999; Ndabigengesere and Narasiah, 1998; Nagar et al., 1982; Oliveira et al., 1999).

Pharmacological Effects of M. oleifera

Radio-Protective and Immunomodulatory Effect

Methanolic extract of *M. oleifera* leaves exerted a

radioprotective effect on radiation-induced chromosomal aberrations and micronuclei (Rao et al., 2001). Methanolic extract of leaves of *M. oleifera* was found to be more significant than other extracts during the study of immunomodulation due to the presence of flavonoids, polyphenols and terpenoids which may modulate the body's immune-mechanisms. Methanol extract stimulates both cellular and humoral immune systems, hence it plays a plausible role on the body's immunity (Bello and Nzeh 2013; Gaikwad et al., 2011).

Ameliorative Effect

M. oleifera leaf extract had a protective effect against the induced testicular toxicity induced by administration of chromium which evidenced by improvement in sperm parameters of experimental rats (Akunna et al., 2012).

Anti-Malarial Effect

Ethanolic extract of *M. oleifera* was found to have anti-malarial effect on some malaria-induced mice. This was also observed in Cyclophosphamide induced toxicity in mice (Gupta et al., 2009).

Anti-Microbial Effect

The powder from fresh leaf juice (dissolved in DMSO) has greater antibacterial activity than fresh leaf juice. Ethanol and water extracts of fresh leaf juice and ethanol extract of fresh leaves showed higher antibacterial potential than the corresponding water extracts when administered to about ten cultured pathogenic bacteria (Rahman et al., 2009).

Hypoglycemic Effect

Administration of *M. oleifera* extracts (root bark, stem bark and leaves) with hypoglycaemic properties was also observed to have lowered the blood sugar levels and could be used for the management of diabetes (Umar et al., 2007).

Other Effects/ Uses

Animal Feed Fortification

Moringa leaves when added to cattle feed increased their daily weight gain by up to 32 percent. Feed of milk cows was supplemented with 15 to 17 kilograms of fresh *Moringa* leaves daily, and the cattle's milk production increased by 43 percent. Feed supplemented with 2 kg dry matter and milk production increased by 58 percent (Foidl et al., 2001; Francis et al., 1991).

Plant Growth Enhancer

Lab experimentation had shown that *Moringa* spray had a wide range of beneficial effects on plant crops. Effects of *Moringa* spray indicated accelerated growth of young plants. Plants were firmer, more resistant to pests and disease. longer life-span, heavier roots, stems and leaves, produced more fruit, larger fruit, increase in yield 20-35% If even a fraction of these results could be reproduced in the field, it could be a great help in increasing food supplies for millions of hungry people (Foidl et al., 2001).

Water Purification

A billion of people across Asia, Africa, and Latin America are estimated to rely on untreated surface water sources for their daily water needs. Of these, some two million are thought to die from diseases caught from contaminated water every year, with the majority of these deaths occurring among children under five years of age. Powdered seed act as a natural flocculent, able to clarify even the most turbid water Seed powder can be used as a quick and simple method for cleaning dirty water. The powder joins with the solids in the water and sinks to the bottom. This treatment also removes 90-99% of bacteria contained in water, water purification by flocculation, sedimentation, antibiosis and even reduction of Schistosome cercariae titer. Using *Moringa* to purify water replaces chemicals such as aluminum sulphate, which are dangerous to people and the environment, and are expensive. Twenty litres of water may be purified by adding 2 grams of powder to one cup of clean water, pour into a bottle and shake for 5 minutes (Gassenschmidt et al., 1995; Jahn et al., 1986; Kumar and Gopal, 1999; Sutherland et al., 1989; Yongbai 2005).

Moringa Oil

The Romans, Greeks and Egyptians extracted edible oil from the seeds and used it for perfume and skin lotion. The extracted *M. oleifera* seed oil revealed an iodine value of 68.63; refractive index (40°C), 1.4571; density (24°C), 0.9032 g cm^{-3}; saponification value, 181.4; unsaponifiable matter, 0.74%; acidity (as oleic acid) 0.81% and color. The major sterol components of the oil were β-sitosterol (46.16%), campesterol (17.59%), stigmasterol (18.80%) and avenasterol (9.26%). The wild *M. oleifera* seed oil was found to contain oleic acid up to 73.22%, followed by

palmitic, stearic, behenic and arachidic acids 6.45, 5.50, 6.16 and 4.08%, respectively and fell in the category of high-oleic oils (Anwar and Bhanger 2003; Dahot and Memon, 1987; Farooq and Rashid, 2007; Fuglie 2001).

Recommendation and Future Prospects

The 21st century is the century of biology powered and derived by scientific knowledge and technology expertise. Three technologies viz. "*Biotechnology*", *Herbal technology*" and "*Information technology (Bioinformatics)*", all these technology are crucial for prosperity and welfare for the people of nations. All technologies for manufacture of value added plant products can be called as "*Herbal technology*".

The climate of India is favorable for the cultivation and plantation of this tree. The State forest Department should take initiative for this purpose. People should be educate and make them aware regarding multifarious use of this "*miracle tree*". India can easily fight against the problems of malnutrition, hunger, poverty, diseases, unemployment, and edible oil export by utilizing its full benefits.

The lot of foreign exchange could be earned by exporting the products of "*Moringa*" instead of spending foreign exchange on imports. This tree truly appears to be a Miracle plant having countless benefits for humanity and thus should be taken as a high quality gift of nature at very low price. The maximum cultivation of this plant in open wastelands, fallow fields, roadsides, around field boundaries, and around houses provides maximum yield of its different useable parts could be achieved to propel the maximal amount of commodities of a multifarious nature for the welfare of humankind.

In view of the edible nature of the plant, more research work can be done on human so that a drug with multifarious effects will be available in the future market. So the State and Central Government must take immediate initiative to plant widely this "miracle indigenous" tree in most of the areas where climatic condition are favorable for maximum yield of its different usable parts.

M. oleifera Lam. is an important source of naturally occurring phytochemicals and this provides a basis for future viable developments like health, socioeconomic developments, cosmetics, as water purifier, etc. Different parts of this miracle tree should also incorporate in various marketed health formulations, such as: Orthoherb (Water Bushnell Ltd., Mumbai, India), Rumalaya and Septilin (The Himalaya Drug Company, Bangalore, India), Livospin (Herbals APS Pvt. Ltd., Patna, India) and Kupid Fort (Pharma Products Pvt. Ltd., Thayavur, India).

Conclusion

Due to its multifarious uses, it is a true "miracle tree". The *M. oleifera* Lam. is providing very good nutrition as protein essential elements supplements, but also a very good in curing and prevention of many diseases in human being. The leaves are extensively used for humankind but also very good cattle feed and handwash. The seed-powder can be used as water purifier, particularly for heavy metals and other impurities in water. The seed oil is also having high values as cosmetics, hair-skin care and as lubricants equivalent to oleic acids. Thus, due to multifarious uses of this tree India and state Government in particular take initiative to plant more and more trees in unutilized areas. India could easily fight against the problems of malnutrition, hunger, poverty, diseases, unemployment and edible oil export and earn lot of foreign exchange. More researches should be undertaken for its optimum production as a crop and its phytochemical should also be isolated for the synthesis of drugs for the utilization of humankind.

This plant truly appears to be a miracle tree having unlimited benefits for people and thus should be taken as a high quality gift of nature at very low price.

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