MORINGA OLEIFERA: A REVIEW OF THE MEDICINAL EVIDENCE OF ITS NUTRITIONAL, THERAPEUTIC AND PROPHYLACTIC PROPERTIES.

SUMMARY

From time immemorial, man has remained dependent on plants for medicine. From a historical perspective, it is evident that the fascination for plants is as old as mankind itself. The plant kingdom represents a rich storehouse of traditional medicines and organic compounds that may lead to development of novel agents for various disorders. *Moringa oleifera* Lam (Syn *Moringa pterygosperma* Gaertn) commonly known by regional names such as drumstick tree, sajiwan, kelor, murungai kaai, saijhan and sajna, is a natural as well as cultivated variety of the genus Moringa belonging to the family Moringaceae. It is a small or medium sized tree, about 10 m high, cultivated throughout India. It is a multipurpose tree known as nature's medicine cabinet. It is best known as excellent source of nutrition and natural energy booster. Different parts of this plant are being employed for the treatment of various ailments in the indigenous system of medicine. It possesses antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic and hepatoprotective activities. This plant have broad spectrum activities so, this review focuses on numerous economic application, distribution and commercial importance of *Moringa oleifera* along with its traditional medicine and culinary uses, so that it can be grown enormously and can be used for various indigenous purposes. Considering its relevance, further research is required to explore the potential from this medicinal tree.

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CHAPTER ONE

INTRODUCTION

1.1 BRIEF HISTORY OF MORINGA OLEIFERA

Moringa oleifera is the most widely cultivated species of a monogeneric family, the moringaceae that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly growing tree(also known as the horse radish tree, drum stick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nebedary, saijhan or ben oil tree), was utilized by the ancient Romans, Greeks and Egyptians, it is now widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan and is being grown in west, east and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the pacific islands. In the west, one of the best known uses for moringa is the use of powdered seeds to flocculate contaminants and purify drinking water but the seeds are also eaten green, wasted, powdered and steeped or tea or used in curies. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, calcium, iron, vitamin c and carotenoids suitable for utilization in many of the so called 'developing' regions of the world where under nourishment is a major concern.

Moringa oleifera is the best known of the thirteen species in the genus moringa. These are moringa oleifera, m. arborea, m. borziana, m. concanensis, m. drouhardii,, m. hildebrandtil, m. longituba, m. ovalifolia, m. peregrine, m. pygmaea, m. ruspoliana, m. stenopetala (mohmood et al, 2010). This fast growing tree is grown for human food, medicine, dye, fodder and water clarification. It has an impressive range of medicinal uses with high nutritional value. In addition to its compelling water water purifying powers and high nutritive value, moringa oleifera is very important for medicinal value. All parts of moringa tree are edible and have long been consumed by human. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act on cardiac and circulatory stimulants, possess antitumor antipyretic, antiepileptic, anti inflammatory (kumar et al, 2009), anti ulcer, anti spasmodic,

diuretic, antihypertensive, cholestrol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in south Asia (anwar et al; 2007, paliwal et al 2011). It is generally known in the developing world as a vegetable, a medicinal plant and a source of vegetable oil. (Bennett et al 2003, paliwal et al. 2011)

Moringa oleifera is a type of tree that has recently attracted the particular interest of dieticians, healthcare professional, health seekers and green organization for its potential to be of tremendous health and ecological benefit to the entirety of mankind. Moringa provides a unique food, attributed with a high protein content and concentration of all amino acids, as well as micronutrients, antioxidants, flavonoids and glucosinolates. It provides an important supplement to low-nutrition foods such as cereals and bulb crops. The plants have always been vital for mankind irrespective of the era and era all over the globe since the beginning of life. These were, are and will remain ever beneficial from nutritional, social, cultural, religious environmental and human health etc. The medicinal plants have greatest potential for benefiting people, especially those living in countries (like Pakistan) suffering from poverty, poor health, malnutrition, unemployment and isolation in international trade. Moringa is very impressive and amazing plant due to its tested, trusted and potential benefits from nutritional as well therapeutic point of views. This friendly plant is of great significance as shown to be useful in water purification, cosmetics, livestock fodders, plant growth enhancer and biogas.

1.2 BOTANICAL DESCRIPTION OF MORINGA OLEIFERA

Moringa is a slender softwood tree that branches freely and can be extremely fast growing. Although it can reach heights in excess of 10m (33ft), it is generally considered a small to medium size tree. Tripinnate compound leaves are feathery with green to dark green elliptical leaflet r 2cm (0.4 – 0.8in) long. The tree is often mistaken for a legume because of its leaves, conspicuous, lightly fragment flowers are borne on inflorescence 10 -25cm (4-10in) long and are generally white to cream colored, although they can be tinged with pink in some varieties.

The fruit is a tri-lobed capsule and is frequently referred to as a 'pod'. Immature pods are green and in some varities have some reddish color.

The fast growing, drought-tolerant moringa oleifera can tolerate poor soil, a wide rainfall range (25- 300 cm per years) and soil ph from 5.0 – 9.0. When fully mature, dried seeds are round or triangular shaped and the kernel is surrounded by a lightly wooded shell with three papery wings. Moringa oleifera seeds contain between 33 and 41% w/w of vegetable oil, it has been investigated that he composition of moringa oleifera, including its fatty acid profile and found that moringa oleifera oil is high in oleic acid (> 70%). The seed contain around 30 – 40% of oil, which has been identified as a source of biofuel and how medicinal value.

Stem: The Stem is normally straight but occasionally is poorly formed. The tree grows with a short, straight stem that reaches a height of 1.5 – 2m before it begins branching but can reach up to 3.0m (foidl et. al, 2001).

Branch: The extended branches grow in a disorganized manner and the canopy is umbrella shaped.

Leaves: Tripinnate compound leaves are feathery with green to dark green elliptical leaflets 1-2cm (0.4 – 0.8in)long. The tree is often mistaken for a legume because of its leaves. The alternate twice or thrice pinnate leaves grown mostly at the branch tips. They are 20-70 cm long, grayish-downy when young, long petiole with 8-10pairs of pinnae each bearing two pairs of opposite ellipetic or obovate leaflets and one at the apex, 1-2cm long (morton, 1991).

Flowers; conspicuous, lightly fragrant flowers are borne on inflorescences 10-25cm (4-10in) long, and are generally white to cream colored, 2.5cm in diameter, borne in sprays, with 5 at the top of the flower, although they can be tinged with pink in some varieties. The flowers, which are pleasantly fragrant and 2.5cm wide are produced profusely in auxiliary, dropping panicles 10-25cm long (sachan et al., 2010). They are white or cream colored and yellow dotted at the base. The five reflexed sepals are linear-lanceolate. The five petals are slender-spatulate. They surround the five stamens and five staminodes and are reflexed except for the lowest.

Fruits: The fruits are trilobed capsules, and are frequently referred to as pods. Immature pods are green and in some varieties have some reddish color. Pods are pendulous, brown, triangular, splitting le lengthwise into 3parts when dry, 30 – 120cm long, 10.8cm wide, containing about 20sec embedded in the pith, pod tapering at both ends, 9-ribbed.

Seeds: The seed are round a brownish semi-permeable seed hull, with 3 papery wings. Seed hulls are generally brown to black, but can be white if kernels are of low viability. Viable seeds germinate within a weeks. The hull itself has three white wings that run from top to bottom at 120 intervals.

1.3 ECOLOGY: ENVIRONMENTAL PREFERENCES AND TOLERANCE

Moringa oleifera can grow at a remarkable rate when young with 3-4m of growth in the first years not being unusual in favorable conditions. In cultivation, trees raised from seed start flowering after 2 years of growth while trees grown from large cuttings can begin to produce fruit 6-12months after planting (bosch 2004). Mature trees eventually reach a height of 6-15m when growing in good conditions. However, plants growing in marginal, conditions grow much slower and can have a stunted and shrubby habit sometimes only reaching 3m in height. This species is deciduous during the dry season and has an enlarged underground rootstock. These two characters make m. oleifera very drought tolerant. In the northern hemisphere, M. oleifera loses its leaves from December to January, though during droughts it may also lose its leaves at other times of the year. New growth usually begins to appear in February to march and flowering often precedes or coincides with the appearance of the new leaves (bosch 2004). The flowing season typically continues through to march while its fruit ripen from April to June.

The bisexual flowers of M. oleifera are highly cross-pollinated and pollination is mainly facilitated by animals (ie the flowers are zoophilous). For example, bees (xylocopa sp) and sunbirds (nectaria spp) have been observed to be active and reliable pollinators in other parts of the world . M. oleifera does not seem to require any specific pollinators as it readily produced viable seed in all parts of the world where it had been introduced (including

Australia). During one study on the mating system of m. oleifera, it was found that 74% of seed were produced as a result of cross-pollination and the remaining 26% of seed were produced by self-fertilization (muluvi et al 2004). While these rates may be influenced by environmental factors, this study confirms that m. oleifera has a mixed mating system and is capable of reproducing from a single individual. A single tree can produce 300-400 fruit per year within 3years of planting while a mature tree can produce up to 1000 fruit per year. As each Fruit contains approximately 20 seeds, a mature tree can therefore produce about 20 000 seeds per year.

CHAPTER TWO

NUTRITIONAL PROPERTIES OF MORINGA OLEIFERA

2.1 NUTRITIVE VALUE OF MORINGA OLEIFERA

In developing tropical countries, moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Three non-governmental organizations in particular-Trees for life, church world service and educational concerns for hunger organization advocate moringa as 'natural nutrition for the tropics'. Leaves can be eaten fresh, cooked or stored as dried powder for many months without refrigeration and loss of nutritional value. Moringa is especially, promising as a food source in the tropics because the tree is in full leaf at the end of the dry season while other foods are typically scare. Analyses of the leaf composition have revealed them to have significant quantities of vitamin A, B and C, calcium, iron and protein.

According to optima of Africa ltd, a group that has been working with the tree in Tanzania, 25 grams daily of moringa leaf powder will give a child' the following recommended daily allowances, protein 42%, calcium 125%, magnesium 61%, potassium 41%, iron 71%, vitamin A 272%, and vitamin c 22%. These numbers are particularly astounding, considering this nutrition is available when other food sources may be scarce.

Analyses of the proximate composition of m. oleifera seeds have showed high level of lipid and proteins (Anhwange et al, 2004) with minor variation. Abdulkarim et al, (2005), have described high levels of total proteins (383.0 standard deviation. SD= 13.0gkg dry matter) which turned out to be greater than important leguminous seeds with respect to human nutrition, whose dry seeds usually contain 18 to 25% of protein, nearly double the contents of cereals. The seed lipid content is greater than that of some soybean varieties (149-200gkg meal). The major saturated fatty acids present in the seeds are palmitic stearic, arachidic and benic acids. Oleic acid is the major unsaturated fatty acid (67.9-70.0) whose high concentration is desirable in terms of nutrition and stability during cooking and frying. Moreover, as a natural source of benic acid,

the m. oleifera seed oil has been used as a solidifying agent in margarines and other food stuffs containing solid and semi solid fat, therefore eliminating hydrogenation processes. Pods and stem contain irrelevant amount of tannins but saponins are alkaloids are present in amounts biologically important in leaves (80kg) and stem, respectively, although in levels considered nontoxic to ruminants. A large number of reports on the nutritional qualities of moringa now exist in both the scientific and the popular literature. Any readers who are familiar with moringa will recognize the oft- produced characterization made many years ago by the trees for life organization, that “ounce for ounce, moringa leaves contains more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin c than orange and more potassium than bananas, and that the protein quality of moringa leaves rivals that of milk and egg. These readers will also recognize the oral histories recorded by Lowell fuglie in Senegal and throughout west Africa, who reports (and has extensively documented on video) countless instances of lifesaving nutritional rescue that are attributed to moringa. In fact, the nutritional properties of moringa are now so well known that there seems to be little doubt of substantial health benefit to be realized consumption of moringa leave powder in situation where starvation is imminent. Nevertheless, the outcomes of well controlled and well documented clinical studies are still clearly of great value.

Moringa tree contains many nutrients such as essential vitamins, essential minerals, amino acids, beta-carotene, anti oxidants and inflammatory nutrients, phytochemicalks and it also contain both omega -3- and omega- 6 fatty acids (kasolo N.j at al). The leaves are highly nutritive, being a significant source of beta carotene vitamin c, protein, iron and potassium. The leaves are cooked and used like spinach. In addition to being used fresh a substitute for greens, its leaves are commonly dried and crushed into powder and used in soups and sauces. The tree is a good source for calcium and phosphorus, moringa leaves and pods are helpful in increasing breast milk in the breast feeding months. One tablespoon of leaf powder can provide 14% of the protein, 40% of the calcium, 23% of the iron and most of the vitamin A needs of a child aged one to three. Six table spoons of leaf powder will provide nearly all of the woman’s daily iron and calcium needs during pregnancy and breastfeeding. The moringa seeds yield 38- 40% edible oil. The refined oil is clear, odorless and resists rancidity at least as well as any other botanical

oil. The seed cake remaining after oil extraction may be used as fertilizers or as a flocculent that forms the particles into a solid to purify water. The nutrients are very important for health and vitality, because m. oleifera contains so many essential nutrients, virtually all the different parts of the tree are being used by local in different countries for a variety of nutritional, medicinal and purification purposes. It is advisable not to consume the roots since researchers have determined that the root is toxic and contains chemicals that can paralyze nerves. Moringa oleifera is sometimes referred to as the 'tree of life' because of its potential to help with malnutrition around the world.

Given its nutritional value, it can be utilized in fortifying sauces, juices, spices, milk, bread and most importantly, instant noodles. Many commercial products like zija soft drink, tea and neutroceuticals are available all over the globe. A comparative study of moringa fresh leaves gram for gram with other foodstuffs puts moringa on top; it contains seven times the vitamin C of oranges, four times the vitamin A of carrots, four times the calcium of milk, three times the potassium of bananas and two times the protein of yogurt. But the micro nutrient content is even more in dried leaves, ten times the vitamin A of carrots, 17 times the calcium of milk, 15 times the potassium of bananas, 25 times the iron of spinach, and nine times the protein of yoghurt , however the vitamin C drops to half that of oranges.

This tree is truly a ''miracle'' tree offering hope, nutritionally, medicinally and economically to devastatingly poor 3rd world countries it has just begun being used as a supplement in a juice form and in powdered leaf tablets.

2.2 NUTRITIONAL CHARACTERIZATION OF MORINGA OLEIFERA LEAVES

Recently, a high degree of renewed interest was placed on the nutritional properties of moringa in most countries where it was not native (Reyes et al, odoro et al, 2008). This could be due to the claims that it increases animal productivity as it has nutritional, therapeutic and prophylactic properties (fahey, 2005). Studies from other countries indicate that the leaves have immense nutritional value such as vitamins, minerals and amino acids (Anwar et al, 2007).

As such, the leaves have been used to combat malnutrition, especially among infants and nursing mothers. There are considerable variations among the nutritional values of moringa which depends on factors like genetic background, environment and cultivation method (Brisibe et al, 2009). As such, it necessitates determination of the nutritive value of moringa of south African ecotype, which could assists in the formulation of diets according to nutrients requirements.

Amino acids, fatty acids, minerals and vitamins are essential in animal feed. These nutrients are used for osmotic adjustment, activate enzymes, hormones and other organic molecules that enancce growth, function and maintenance of the process (Anjorin et al, 2010).

Chemical composition of dried leaves of moringa (m. oleifera lam)

Nutritive value	Dry leaf	Standard error
Moisture (%)	9.533	0.194
Crude protein (%)	30.29	1.480
Fat (%)	6.50	1.042
Ash (%)	7.64	0.433
Neutral detergent fibre(%)	11.40	0.425
Acid detergent fibre(%)	8.49	0.348
Acid detergent lignin(%)	1.8	2.204
Acid detergent cellulose(%)	4.01	0.101
Condensed tannins(mg/g)	3.12	0.104
Total polyphenols(%)	2.02	0.390

Source: (Busani, M., Patrick, J. M., Arnold, H. and Voster, M. (2011)

Amino acids compositon of dried moringa (m. oleifera lam) leaves

Amino acid	Quantity (mean +/- %)	Standard error
Argenine	1.78	0.010
Serine	1.087	0.035
Aspartic acid	1.43	0.045
Glutamic acid	2.53	0.062
Glycine	1.533	0.060
Threonine	1.357	0.124
Alanine	3.033	0.006
Tyrosine	2.650	0.015
Proline	1.203	0.006
Ho-proline	0.093	0.006
Methonine	0.297	0.006
Valine	1.413	0.021
Phenylalanine	1.64	0.006
Isoleucine	1.177	0.006
Leucine	1.96	0.010
Histidine	0.716	0.006
Lysine	1.637	0.006
Cysteine	0.01	0.000
Tryptophan	0.486	0.001

Source: (Busani, M., Patrick, J. M., Arnold, H. and Voster, M. (2011)

Moringa is reported to have high quality protein which is easily digested and that is influenced by the quality of its amino acids (foidl et al, 2001). In this study, the dried moringa leaves contained 19 amino acids, which slightly differ from the findings of foidl et al.(2001) and

sanchez machado et al,. (2009) which reported 18 and 16 amino acids respectively. Methionine and cystine are powerful antioxidants that help in the detoxification of harmful compounds and protect the body from radiation (brisibe et al, 2009). Ho-proline is a major component of the protein collagen, it plays a key role in collage stability.

Mineral contents of dried moringa (m. oleifera lam) leaves

Mineral	Dry leaf	Standard error
Macro-elements (%)		
Calcium (%)	3.65	0.036
Phosphorous (%)	0.30	0.004
Magnesium (%)	0.50	0.005
Potassium (%)	1.50	0.019
Sodium (%)	0.164	0.017
Sulphur (%)	0.63	0.146
Micro elements (mg/kg)		
Zinc (mg/kg)	31.03	3.410
Copper (mg/kg)	8.25	0.143
Manganese (mg/kg)	86.8	3.940
Iron (mg/kg)	490	49.645
Selenium (mg/kg)	363.00	0.413
Boron (mg/kg)	49.93	2.302

Source: (Busani, M., Patrick, J. M., Arnold, H. and Voster, M. (2011)

The dry leaves could serve as a protein supplementary source in animal and human diets. This protein content is of particular nutritional significance since it has been suggested that amino acid supplementation is important in meeting a substantial proportion of an animal protein and energy requirements (Brisibe et al, 2009).

It is also of remarkable interest that the dried moringa leaves have high deposit of mineral elements. Calcium was observed to be higher compared with other plant sources (Nkafamiya et al. 2010). It is required for formation and maintenance of bones and teeth thus, preventing osteoporosis. It is also needed for normal blood clothing and nervous function.

Interestingly, even iron which is commonly deficient in many plant-based diets, was found in abundance in this plant's leaves iron is a necessary component of haemoglobin and myoglobin for oxygen transport and cellular processes of growth and division (kozat, 2007). The presence of zn in high amounts is of special interest in view of the importance of the inclusion of zn in the diet of animals and humans. Zinc is also required for cell reproduction and growth especially sperm cells. In addition, Zn is known for its antiviral, anti bacterial, anti fungal and anti cancer properties (brisibe et al, 2009)

The moringa dried leaves contained copper, which is considered to have strong effects on the immune system (anwar et al, 2002), copper is involved in stimulating body defense system, as it is active in neutrophil production and affects phagocyte killing ability. It is required for antibody development and lymphocyte killing ability. It is required for antibody development and lymphocyte replication (burke and miller, 2006). Moringa has sulpur that is necessary for efficiency of rumen microbial growth and activity (brisible et al, 2009). The dried powdered moringa leaves have high levels of vitamin E and beta carotene. Moringa powder have been reported to be rich in beta-caroline, thiamine, riboflavin, niacin, pyrodixine, biotin, ascorbic acid, cholecalciferol, tocophenol and vitamin k (broin, 2006). Beta carotene rich moringa leaves can thus be an important sources of vitamin A, can be used for releasing the bound iron status and thus, help in reducing anaemia as well as prevalence of vitamin A deficiency. Moringa powder is, however, rich in vitamin such that it is one of the richest plant sources of vitamin (anwar et al, 2007).

In conclusion, the data derived from nutrient characterization of moringa are clear indications that the plant leaves are rich nutrients and has potential to be used as a feed additive with multiple purposes.These include serving as a protein, fatty acid, mineral and vitamin resources for animal and human feed formulation. Drying the leaves assists to concentrate the nutrients,

facilitate conservation and consumption, as such, it can be used during the time when feed is scarce or transported to areas where it is not cultivated, it is suggested that moringa should be consumed in powdered form. Its inclusion in the diets could function as curative and therapeutic therapy. As such, it can be used to improve health and nutrition.

2.3 THE VITAMIN CONTENT OF MORINGA OLEIFERA LEAF POWDER

Moringa oleifera is rich with diverse vitamins, minerals and amino acids. Best of all, these nutrients are readily available for your body use. The great majority of multivitamins available in the supermarket today are created in laboratories, where ingredients are synthesized and packed into a small pill. Unfortunately, most of these ingredients are not easily absorbed by the body because they are not sourced from whole foods. Moringa is a natural, whole food source for vitamins, minerals, proteins, antioxidants and other important compounds that your body relies on to stay healthy. A single moringa capsule contains a full spectrum of nutrients.

Moringa's benefits are derived from the plant's high concentration of bio-available nutrients. It contains high levels of vitamin A (beta-carotene), vitamin B1 (thiamine), vitamine B2 (riboflavin), vitamin B3 (niacin), Vitamin B6 (pyridoxine), vitamin B7 (Biotin), vitamin C (ascorbic acid), vitamin D (cholecalciferol), vitamin E (tocopherol) and vitamin E.

VITAMIN A (beta carotene) is needed by the retina of the eye in the form of a specific metabolite, the light absorbing molecule retinal. This molecule is absolutely necessary for both scotopic vision and color vision. Vitamin A also functions in a very different role as an irreversible oxidized form retinoic acid, which is an important hormone-like growth factor for epithelial and other cells. It is believed that vitamin A is the most important vitamin for immune protection against all kinds of infections. It is involved in healing and bone development. Beta-carotene guards against heart diseases and can keep harmful lipoproteins containing

cholesterol from damaging the heart and coronary arteries. It also helps to prevent certain types of cancers and stroke.

VITAMIN B1 (thiamine): helps fuel the body by converting blood sugar into energy. It keeps the mucous membrances healthy and is essential for the nervous system and cardiovascular and muscular functions. Moringa leaves contain high amounts of vitamins B1 even compared with the best sources already known. It is higher than green peas, black beans (boiled) and corn (boiled). Vitamin b1 is vital for the production of energy in each cell and it plays an essential role in the metabolism of various carbohydrates.

VITAMIN B2 (riboflavin) is required for a wide variety of cellular processes. Like the other B vitamins, it plays a key role in energy metabolism and of the metabolism of fats, ketone bodies, carbohydrates and proteins. It is the central component of the cofactor FAD and FMN, and is therefore required by all 'flavoproteins'. It is needed to activate viamin B6 and assist the adrenal glands. It is important for red blood cell formation antibody production and growth. It is required for healthy mucous membranes, skin and for the absorption of iron and certain vitamins.

VITAMIN B3 (niacin): Like all B complex vitamins is necessary for healthy skin, hair, eyes and liver. It also helps the nervous system function properly. Niacin helps the body produce sex and stress related hormones in the adrenal glands and other parts of the body. It is effective in improving circultation and reducing cholesterol levels in the blood. Moringa leaves and pods contain about 0.5 to 0.8 mg of vitamin B3 per 100 gram (about 3 ounce vitamin B3 is important for energy production and metabolism of protein, fats and carbohydrates. It supports the function of the digestive system and promotes healthy skin and nerves.

VITAMIN B6 (pyridoxine) is required for the synthesis of the neurotransmitters serotonin and norepinephrin and for myelin formation pyridoxine deficiency in adults principally affects the peripheral nerves, skin, mucous membranes and the blood cell system.

VITAMIN B7 (biotin) has vital metabolic functions. Without biotin as a co-factor, many enzymes do not work properly and serious complications can occur, including varied diseases of the skin,

intestinal tract and nervous system. Biotin can help address high blood glucose levels in people with type 2 diabetes and is helpful in maintaining healthy hair and nails, decreasing insulin resistance and improving glucose tolerance and possibly preventing birth defects. It plays a role in energy metabolism and has been used to treat alopecia, cancer, crohn's disease e.t,c

VITAMIN C (ascorbic acid) just one ounce of moringa leaves contain the daily recommended amount of vitamin C (60mg). In fact, it is so rich in vitamin C that ounce per ounce, it contain 6-7times that found in orange juice. Vitamin C strengthens our immue system and fight infectious disease including colds & flu, protects against cardiovascular disease, prenatal health problems, eye disease and wrinkles.

VITAMIN D (cholecalciferol) is essential for promoting calcium absorption in the gut and maintaining adequate serum calcium and phosphate concentrations to enable normal mineralization of bone and prevent hypocalcaemia telany. Vitamin D sufficiency prevents rickets in children and osteomalacia in adults. Vitamin D has other roles in human health, including modulation of neuromuscular and immune function and reduction of inflammation

VITAMIN E: moringa contains large amounts of vitamin E, at 113 mg per 10g (about 3oz) of the dried leaf powder. The recommended daily intake of vitamin E is 10mg. vitamin E is a potent anti oxidant that helps prevent premature aging and degenerative disease including heart disease, arthritis, diabetes and cancer. It is also protects the body from pollution, increases stamina and reduces or prevents hot flashes in menopause. It promotes young looking skin, as well as healing and reducing scar tissue from forming.

VITAMIN K: IS NEEDED for blood to properly clot and for the liver to make blood clotting factors, including factor II (prothrombin), factor vii (proconvertin), factor ix (thrombiplastin component) and factor x (stuart factor). Other clotting factors that depend on vitamin k are protein C, protein S and protein Z.

2.4 NUTRITIVE USES OF MORINGA OLEIFERA

Moringa oleifera is the most nutrient –rich plant yet discovered. This humble plant has been making strides in less-developed societies for thousands of years and significant nutritional research has been conducted since the 1970s. moringa provides a rich and rare combination of nutrients, amino acids, antioxidants, antiaging and anti-inflammatory properties used for nutrition and healing. Moringa is sometimes called “mother’s best friend’ and ‘miracle tree’, moringa has been in use since centuries for nutritional as well medicinal purposes. These include vitamin C, which fights a host of illnesses including cold and flu, vitamin A, which acts as a shield against eye diseases, skin disease, heart ailments, diarrhea and many other diseases. Calcium, which builds strong bones, and teeth and helps prevent osteoporosis, potassium, which is essential for the functioning of the brain and nerves and proteins, the basic building blocks of all our body cells. Moringa even contains argenine and histidine, two amino acids especially important for infacts who are unable to make enough protein for their growth requirement.

POD: the moringa fruit is a long thin pod resembling a drumstick. It is used to prepare a variety of sambar and is also fried. It is also preserved by canning and exported worldwide. It can be made into a variety of curry dishes by mixing with coconut, poppy seeds and mustard. It can be boiled until the drumsticks are semi-soft and consumed directly without any extra processing or cooking. It is used in curries, sambars, korm.

LEAVES: The moringa Oleifera leaves are highly nutritious, being a significant source of beta –carotene, vitamin C, protein, iron and potassium. The leaves are cooked and used like spinach. In addition to being used fresh as a substitute for spinach. Its leaves are commonly dried and crushed into a powder and used in soups and sauces.

FLOWER: The flowers are edible when cooked and are said to taste like mushrooms.

BEN OIL: The moringa seeds yield 38-40% edible oil. The refined oil is clear, odorless and resists rancidity at least as well as any other botanical oil. The seed cake remaining after oil extraction may be used fertilizer or as flocculent to purify water. Oil from the seed, called oil of Ben is used for ear ache and in ointments for skin conditions. The oil rubbed on the skin is said to prevent mosquitoes from biting. Flowers infused in honey are used as a cough remedy.

INDUSTRIES USES: the seed oil is used in arts and for lubricating watches and other delicate machinery and useful in the manufacture of perfumes and hair dressing. The pressed cake obtained after oil extraction may be used as a fertilizer. The industrial uses of the drumstick tree include the use of its wood in paper and textiles industries, bark in the tanning industry. The oil from the seeds contain a powerful flocculent of use in clarifying turbid water.

PHYTOCHEMISTRY

Phytochemicals are, in the strictest sense of the word, chemicals produced by plants. Commonly, though, the word refers to only those chemicals which may have an impact on health, or on flavor, texture, smell, or color of the plants, but are not required by humans as essential nutrients. An examination of the phytochemicals of Moringa species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it is rich in a fairly unique group of compounds called glucosinolates and isothiocyanates (10,38). For example, specific components of Moringa preparations that have been reported to have hypo- tensive, anticancer, and antibacterial activity include 4- (4'-*O*-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocy- anate **[1],** 4-(α-L-rhamnopyranosyloxy)benzyl isothiocy- anate **[2],** niazimicin **[3]**, pterygospermin **[4],** benzyl isothiocyanate **[5],** and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate **[6].** While these compounds are relatively unique to the Moringa family, it is also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A).These attributes are all discussed extensively by Lowell
Fuglie (47) and others, and will be the subject of a future review in this series.

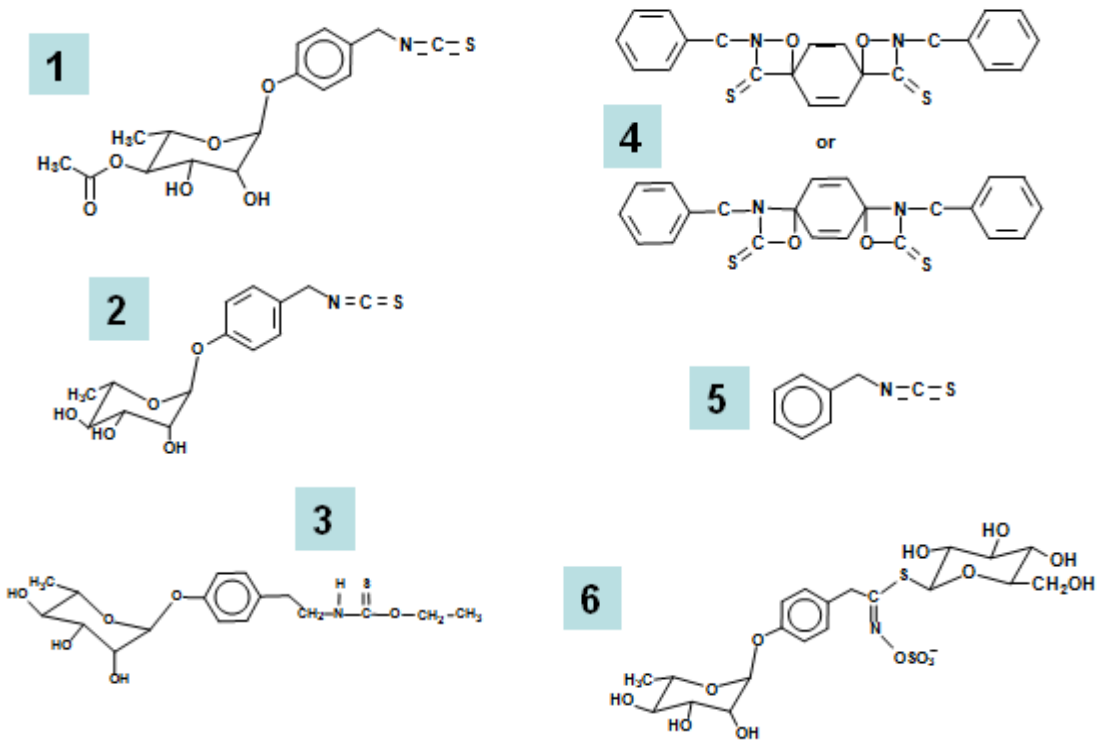

Figure 1. Structures of selected phytochemicals from Moringa spp.: 4-(4'-*O*-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocyanate **[1]**, 4-(-L-rhamnopyranosyloxy)benzyl isothiocyanate **[2]**, niazimicin **[3]**, pterygospermin **[4]**, benzyl isothiocyanate **[5]**, and 4-(α-L-rhamnopyranosyloxy)benzyl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

CHAPTER THREE

THERAPEUTIC PROPERTIES OF MORINGA OLEIFERA

3.1 THERAPEUTIC USES OF MORINGA OLEIFERA

The use of moringa for medical purposes is abundant. The juice of the leaves is believed to stabilize blood pressure, the flowers are used to our inflammations, the pods are used for joint pain, the roots are used to treat rheumatism, and the bark can be chewed as a digestive. In both areas in india studied by the authors (kerala and tamil nadu), the bark of the roots are used to treat ‘‘painful and difficult urination” as well as kidney stones. The leaves are rich food in vitamin A, C and D as well as the flowers are eaten cooked as food. They are also used for medicinal purposes such as against headaches, sore eye and wounds for which leaf-paste is applied.

Further uses include the treatment of aneamia, colds, fevers, flues, cataract issues as well as night blindness, odemas, tuberculosis as well as calcium deficiencies. In the Philippines the use of moringa includes inter alia the seeds bing boiled like beans and used for treatment of diabetes. The leaves are used for their antiseptic characteristics. The bark is mixed with coconut oil applied to inside of the bark and wrapped around fractures to treat them, women are given moringa post partum as the boiled leaves are used to induce lactation as well as to prevent anemia.

Purdue university mentions that according to hartwel (1967-1971), the flowers leaves and roots are used in folk remedies for tumours, the seeds for abdominal tumors. The root decoction is used in some countries for dropsy. Root juices is applied externally as rubefacient or cunter-irritant. Leaves applied as poultice to sores, rubbed on the temples or headaches and said to have purgative properties. Bark regarded as antiscorbic and exudes a reddish gum with properties of trangacanth, sometimes used for diarrhea, roots are bitter, act as a tonic to the body and lungs and are expectorant, mild diuretic and stimulant in paralytic afflictions, epilepsy and hysteria.

3.2 USE OF MORINGA OLEIFERA IN CURE OF DISEASES

The moringa oleifera plant has been identified as an extremely useful medicinal plant with significant health benefits. The moringa tree has great use medicinally both as preventive and treatment. Moringa oleifera bark, sap, roots, leaves, seeds, oil and flowers are used in traditional medicine in several countries. A folk remedy for stomach complaints, catarrh, cancer, gastric ulcers, skin diseases, lowering blood sugar, increasing bone density, nervous conditions, diabetes, fatigues, increase lactation, hay fever, impotence, edema, cramps, hemorrhoids, headaches, sore gums to strengthen the eyes and the brain, liver, gall disgestive , respiratory and immune system and as a blood cleanser and blood builder. An infusion of leaves is used as an eye wash for treating conjunctivitis. Soup prepared with drumstick leaves is extremely beneficial for the natural prevention for tuberculosis, bronchitis and asthma.

According to Hartwell (1967-1971), the drumstick flowers leaves, seeds and roots are used for tumors, roots are bitter, act as a tonic to the body and lungs, and are expectorant, diuretic and stimulant in paralytic afflictions, epilepsy and hysteria.

3.2.1 Moringa and inflammation

The moringa plant is well known for its therapeutic effects in both modern medicine and tranditional practice. Formally known as moringa oleferia, this versatile and nutritious plant is currently the subject of intense scrutiny by the medical establishment to determine its utility in treating and preventing a variety of diseases, one of the most promising uses of moringa extract is in the treatment of various types of acute and chronic inflammations.

Moringa extract supplements have been shown to reduce the level of inflammation in laboratory animal in both chronic and acute cases. Further studies are currently underway to assess the effectiveness of this treatment, but it can be safely assumed that a regular of moringa supplements may produce safe, reliable reduction in inflammation for most individuals with chronic inflammatory diseases.

3.2.2 Moringa and cancer

Moringa oleifera is rich with powerful antioxidants which serves the body's health by eliminating free radicals, cancer causing substances that build up in the body and lead to the onset of carcinogenic growth. Unlike most other foods rich in antioxidant, moringa oleifera contains a uniquely powerful combination of antioxidants, which work together to make moringa one of nature's most potent antioxidant sources. Moringa has been demonstrated to be an effective antibiotics against bacteria, some of which are known carcinogens.

Moringa has also been shown to be effective against Burkett's lymphoma, lymphatic cancer that is highly prevalent in people with HIV and AIDS, a clinical study demonstrated that compounds found in moringa oleifera inhibited the activation of burkett's lymphoma cells. Further controlled investigation demonstrated that moringa dramatically reduced the prevalence of skin papillomas, also known as skin lags which can become malignant in some cases when not treated. Moringa oleifera is as a source of strong anti-cancer compounds for female reproductive disorders, including ovarian cancer.

3.2.3 The role of moringa powder in treating HIV/AIDS

Moringa oleifera is a versatile; highly a nutritrious plant that grows in a wide range of cimates and can survive for extended periods in dry, near-drought conditions. Moringa leaves contain powerful antioxidants that can help prevent or delay some of the worse complications arising from AIDS. The proceedings of the 14^{th} international AIDS conference held in Barcelona, Spain in 2002 included a recommendation that moringa powder be considered as an alternative treatment to boost the immue systems of HIV positive patients in Africa. Because moringa also provides superior nutritional value for patients, it can also prove useful in preventing immune system breakdown due to malnutrition, while moringa's antioxidant and nutritional benefits

cannot directly compete with the superior results of modern antiretroviral, it shows promise in providing reduced mortality rates and improved health for HIV positive and AIDS patients in these less developed areas.

3.2.4 Moringa oleifera: preserving liver function

The moringa oleifera plant has been identified as an extremely useful medicinal plant with significant health benefits. Scientific studies have shown that moringa supplements can reduce damage to the liver caused by prescription and over-the-counter medications and in some cases may even repair the damage and protect against further injury to the liver from illness or the use of prescription and nonprescription drugs. The therapeutic effects of moringa supplements are still being investigated, but medical research has already proven several beneficial effects of this versatile herb in treating and protecting against lives dysfunction in sensitive patients.

Moringa supplements may help to reduce and reverse the effects of liver disease and restore improved functioning to the liver, allowing it to more effectively filter toxins from the body.

3.3 TRADITIONAL MEDICINAL EFFECTS OF MORINGA OLEIFERA

Moringa has been used in the traditional medicine passed down for centuries in many cultures around the world, for skin infections, anemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis, cough, diarrhea, eye and ear infection, fever, glandular, swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation, diabetes and pregnancy (Nikkon, et al, 2003). Moringa oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. Moringa oil has been used in skin preparation and ointments since

Egyptian times. (Fugile L. J(2001), Marcus M. G. (2005), Sairam, T. V (1999), tree for like (2005) , Ramachandran et al (1980).

Medicinal properties of plants have also been investigated in the light of recent scientific developments through out the world, due to their potent pharmological activities, low toxicity and economic viability, when compared with synthetic drug (prachta et al; 2011). Among myriad of natural plants moringa oleifera lam. is called miracle vegetable because of it is both a medicinal and a functional food. Due to its hot potency, it is helpful in relieving from pain and also reduces inflammation. It is also helpful in curbing the infection in the body. It is very much effective in stimulating the nervous system. Due to pungent taste it is effective in treating the digestive disorder, worm infestation, and constipation. It stimulates heart and also increases the blood density because of its hot potency; it is also a good antitussive and helps in resolving from extra mucus in the respiratiory tract because of its bitter nature. Due to hot potency, it is helpful in maintaining the proper menstrual cycle. It is also helpful in relieving from skin related problems as it generates sweat in the body.

Traditional uses of moringa oleifera was denoted in many ancient books which are as follows:

Plant part	Traditional uses
Leaves	Antibacterial infection, urinary tract infection, HIV-AIDS, fever, hepatic, anti-tumor,anti-hypertensive, thyroid, diarrhea,dysentery, ulcer, headache, antioxidant, protein, iron deficiency, vitamin (mineral deficiency, lactation enhancer, catarrh, scurvy and tonic.
Roots	Dental caries/toothache, common cold, fever, asthma, diarrhea, flatulence, epilepsy, hysteria headache, gout, low back/kidney pain, scurvy.
Bark	Dental caries/toothache, common cold, sore/ulcer, antitumor, snake bite, scorpion

	bite, digestive, epilepsy, hysteria, headache, birth control and scurvy.
Flowers	Throat infections, common cold, antitumor, rheumatism, tonic abortion, hysteria.
Pods	Skin cancer, anti-hypertensive, diabetes, joint pain.
Seeds	Warts, antitumor, ulcer, rheumatism, arthritis, mineral/vitamin deficiency.
Exudates	Dental caries/ toothache, syphilis, typhoid, earache, fever, asthma, dysentery, headache, rheumatism.,

Source: (Fahey J.W 2005, Nadkarni K. M; Mashr. G et al, 2011, Rajangam .J. 2001).

CHAPTER FOUR

PROPHYLACTIC PROPERTIES OF MORINGA OLEIFERA

According to Dr Lydia M. of the food and nutrition research institution of the world's most useful plants, it is effective flocculant of water treatment, antibiotic, source of oil and coagulant for turbid waters. For centuries, many cultures have looked to moringa as a general remedy and healing agent. It has been referred to as the miracle plant.moringa's benefits are both broad and compelling. Legend has it that moringa's effectiveness is known for treating more than 300 conditions and has been heavily utilized in folk medicine to treat a variety of health conditions. It has been targeted on the discovery channel as one of the best all natural supplements in the world.

In addition to its compelling water purifying powers and high nutritional value, moringa oleifera is very important for its medicinal value. Various parts of this plant such as the leaves, roots, seeds, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti inflammatory, anti ulcer, antispasmodic, diuretic, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities and are being employed for the treatment of different ailment in the indigenous system of medicine. (Anwar et al., 2007).

4.1 ANTISPASMODIC, ANTIULCER & HEPATOPROTECTIVE ACTIVITES

Moringa oleifera have been reported to possess antispasmodic activity (caceres et al., 1992). The antispomdic activity of the ethanol extract of moringa oleifera leaves has been attributed to the presence of { -(L- rhamnosyloxy) benzyl]-o-methyl) thiocarbamate (basher, et al., 2006) which forms the basis for its traditional use in diarrhea (Gilani et al., 1992). Aqueous leaf extracts also showed antiulcer effect (Pal et al., 1995) indicating that the antiulcer component is widely distributed in this plant.

Moringa roots have also been reported to possess hepatoprotective activity (Ruckmani et al., 1998).

4.2 ANTIBACTERIAL & ANTIFUNGAL ACTIVITIES

Moringa roots have antibacterial activity (Rao et al., 1996) and are reported to be rich in antimicrobial agents. These are reported to contain an active antibiotics principle, pterydospermin (broin .m. et al., 2002) which has powerful antibacterial and fungicide effects (Ruckmani et al., 1998). The bark extract has been shown to possess antifungal activity (Bhatnagar et al., 1961) while the juice from the stem bark showed antibacterial effect against staphylococcus aureus (melita et al., 2003). The fresh leaf juice was found to inhibit the growth of microorganism (pseudomonas aeruginosa & staphylococcus aureus), pathogenic to man (Caceres et al., 1991).

4.3 ANTITUMOR & ANTICANCER ACTIVITIES

Makonnen et al., (1997) found moringa leaves to be a potential source for antitumor activity. Niazimicin has been proposed be a potent chemopreventive agent in chemical carcinogenesis (Guevara et al., 1999). The seed extracts have also been found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameter and skin pappillomagenesis in mice.(Bharali et al ., 2003). It has been found that niaziminin (Broin .m. et al, Brostlap AC et al., 1988), a thiocarbamate from the leaves of moringa oleifera exhibits imhibition of tumor-promoter-induced Epstein-barr virus activation.

A recent report showed that moringa oleifera may be applicable as a prophylactic or therapeutic anti-HSV (Herpes simplex virus type 1) medicine & may be effective against the acyclovir-resistant variant (lipipun et al., 2003). Moringa oleifera is coming to the forefront as a result of scientific evidence that moringa is an important source of naturally occurring

phytochemical & this provides a basis for future viable developments. Moringa seeds have specific protein fractions for skin & hair care.

CONCLUSION

Moringa is a tree with proven medicinal properties. There are many benefits of the moringa tree, but the health benefits are the most important. It has more nutritional values. Moringa oleifera Lam (Moringaceae) is a highly valued plant, distributed in many countries of the tropics and subtropics. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, beta-carotene, amino acids and various phenolics. The Moringa plant provides a rich and rare combination of zeatin, quercetin, beta-sitosterol, caffeoylquinic acid and kaempferol. In addition to its compelling water purifying powers and high nutritional value, M. oleifera is very important for its medicinal value. Various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, antiinflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia.

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