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Review Article

Review of the Nutritive, Medicinal and General Economic Potentials of *Moringa Oleifera*

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Abstract: This paper reviews the Nutritive, Medicinal and General Economic Importance of *Moringa Oleifera*. *Moringa oleifera* also known as drum stick, horseradish tree or miracle tree is native to India and grows in the tropical and subtropical regions of the world. Moringa can withstand both severe drought 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. *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 explores 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: Review, Nutritive value, Medicinal, Economic potentials and Moringa oleifera.

INTRODUCTION

Moringa oleifera also known as the Miracle Tree, Drum Stick or Horseradish Tree grows in many tropical and subtropical countries as explained by (Nambiar *et al.*, 2010). It is grown for commercial purposes in places like South and Central America, Africa, India, Hawaii, Mexico and Asia. It was named "horseradish" tree" on the basis of ground root taste preparations, It was also named "drumstick tree" on the basis of its immature seed pods appearance and the "ben oil" tree on the basis of seed-derived oils. In some places, the immature seed pods are eaten, while the fresh leaves are commonly used as a basic food due to their high nutritional composition. According to Foidi *et al.*, (2010) *M. oleifera* tree belongs to the family of Moringaceae, it is commonly called "drumstick tree" or horse radish tree, and locally called "zogale" in Hausa, Nigeria. It was well known for its multipurpose attributes, wide adoptability, and ease of establishment. Its leaves, pods, and flowers are packed with nutrients important to both human and animals. *M. oleifera* is a native to north India but is now found throughout the tropics. It is also known as horse radish tree, drumstick tree, miracle tree and mothers best friend, it grows fast and reaches up to 12m tall. The bark is grey and looks like cork peeling in patches (Williams *et al.*, 2013). *M. oleifera* is adopted to a wide range of loamy to clay loam, it does not withstand prolonged water logging, it is preserved to prefer a neutral to slightly acidic soil been introduced with success to pacific tolls where soil pH is commonly greater than 8.5, it does best where temperature ranges from 25 °c to 40 °c and optimum annual rainfall total of 500mm.lt grows well from sea level to 10 m in elevation. *M. oleifera* has its origin in the Arabia and India. Today, the tree is common to landscape all over the tropical area of the world, from south Asia to West Africa. It is most visible in parts of east South Africa. *M. oleifera* is not a nitrogen fixing tree, but its fruits, flowers and leaves all contain 5% to 10% protein on average. All of these parts are eaten widely as vegetables; provide excellent food, for both humans and eaten like green beans. Evison *et al.*, (2015) posits that the roots of moringa taste similar to horse radish and is popular food (leaves) in the East

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Africa. Moringa flowers also produce a good honey. The wood is light, but provides a fairly good fuel for cooking. It has density of 0.5-0.7 and yield approximately 4,600kcaL/kg. The seeds are usually used as anticoagulant. Harvested dry seed are shelled crushed in to powdered form and made in to paste with the water before mixing with more water. The mixed water is then allowed to settle and sieved its turbidity is extensively reduced including hardness reduction. The aim of this paper was to review *M. oleifera* as a potential miracle tree and to give more emphasis on it uses as expressed by (Bashir *et al.*, 2014).

Atli (2015) lamented that moringa is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach The fact that moringa is easily cultivable makes it a sustainable remedy for malnutrition. Countries like Senegal and Benin treat children with moringa. Children deprived of breast milk tend to show symptoms of malnutrition. Lactogogues are generally prescribed to lactating mothers to augment milk production. The lactogogue, made of phytosterols, acts as a precursor for hormones required for reproductive growth. Moringa is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones. Price (2000) is of the opinion that the compounds in moringa parts increase the estrogen production, which in turn stimulates the proliferation of the mammary gland ducts to produce milk. It is used to treat malnutrition in children younger than 3 years. About 6 spoonfuls of leaf powder can meet a woman's daily iron and calcium requirements, during pregnancy. This study provides an overview on the cultivation, nutritional values, medicinal properties for commercial use and pharmacological properties of moringa. There are no elaborate reports on treatment of diabetes and cancer using moringa. This study aims to bridge the gap as explained by (Odee, 2008).

Botany of Drumstick Tree (Moringa oleifera)

According to Makker and Becker (2017) *M. oleifera* is fast growing perennials tree, which can reach a maximum height of 7-12m and a diameter of 20-60cm at chest height. The stem is normally straight, the tree grow with short, straight stem that reaches a height of 1.5-2.0m before it begins branching and it can reach up to 3.0m. The extended branches growing in a dis-organized manner and the canopy is umbrella shape. The leaves are alternate, twice or thrice pinnate leaves grow mostly at the branch tips, they are 20-70m grayish downy when young, long petiole with 8-10 pair of pinnate each bearing two pairs of opposite, elliptic or obviate leaflet and at the apex, all 1-2cm with glands at bases of the petiole and pinnate. Morton (2019) found out that the flowers, which are pleasantly fragrant, and 2.5cm wide are produced profusely in maxillary, drooping panides 10-25cm long. They are white or cream coloured and yellow doted at the base. The five reflexes sepals are linear lanceolate. The five (5) petals are slender spatulate, the surround the five (5) stamen and five (5) nodes and are a reflexed except for the lowest. The fruits are three lobed pods which hang down from the branches and are 20-60cm in length when they are dry open into 3 parts, each pods contains between 12-35 seeds. The seeds are round with a brownish semi permeable seed hull. The hull itself has three (3) wings that run from top to the bottom at „120 degree intervals. Each tree can produce between 15,000 and 25,000 seeds per year. Muyibi and Evison (2009) supported that the average weight per seed is 150.3g and the kernel to hull ratio is 7.2cm. Drumstick Tree as a Potential Miracle Tree All parts of M. oleifera can be used in a variety of ways. Moringa leaves is full of nutrients and vitamins. *M. oleifera* leaves were reported to have 25.1% crude protein, 0.50% methionine and a metabolisable energy value of 227lkcal/kg. A survey of over 120 species of tropical and subtropical edible plants for nutrient content, antioxidant activity, and a crop trait indicated that M. oleifera is one of the promising crops which could contribute to increased intake of micronutrient and antioxidant. *M. oleifera* leaves can be excellent sources of calcium, potassium and protein. It was also reported that the leaves of *M. oleifera* plant is an excellent source of vitamins, mineral and protein perhaps more than any other tropical vegetable. Moringa leaves extract have been reported to exhibit antimicrobial activities including inhibition for the growth of Staphylococcus aureus that are commonly isolated from food and animals intestines, It also has a medicinal uses among the natives (Morton, 2019). In view of the above importance of *M. oleifera*, and some that are yet to be discovered, it's important to have a comprehensive study of the Plant as whole. Moringa oleifera is a perennial tree, having well developed roots, stem and leaves; it can be used in many ways. Researches on *M. oleifera* tree have accumulated different information on the uses of the plant in human consumption, medicinal uses, animal fodder, water purification, fertilizer, living fence, alley cropping, natural pesticide, fuel wood, and growth hormone for plant.

Plantation and soil conditions

M. oleifera can be grown in any tropical and subtropical regions of the world with a temperature around 25–35 ◦C (Fuglie, 1999). It requires sandy or loamy soil with a slightly acidic to slightly alkaline pH and a net rainfall of 250–3000 mm. The direct seeding method is followed as it has high germination rates. Since moringa seeds are expected to germinate within 5–12 days after seeding and can be implanted at a depth of 2 cm in the soil. Moringa can also be propagated using containers. The saplings are placed in plastic bags containing sandy or loamy soil. After it grows to about 30 cm, it can be transplanted. However, utmost care has to be taken while transplanting as the tap roots are tender and tend to get affected (Thumber and Fahey

2009). The tree can also be cultivated from cuttings with 1 m length and 4–5 cm in diameter, but these plants may not have a good deep root system. Such plants tend to be sensitive to drought and winds. For commercial purposes large scale intensive and semi-intensive plantation of moringa may be followed. In commercial cultivation, spacing is important as it helps in plant management and harvest. *M. oleifera* differs in nutrient composition at different locations. The tree grown in India has slightly different nutritional components than a tree grown in Nigeria. The nutritional differences in the leaves from two ecological locations semi-deciduous and Savannah regions. It showed that the latter was less nutritious than the former and attributed this to high temperatures at the Savannah regions. At higher temperature, proteins and enzymes get denatured and this could be the cause for the difference in nutrient content. Soil is an important factor that defines nutrient content and strength of the plant. Fertilizers when applied solely or in combination with others resulted in different nutrient compositions on plant parts. NPK fertilizer, poultry manure and organic base fertilizer was provided to study the effect on the nutrient content and found that poultry manure gave the best results than phosphorous, potassium, sodium and manganese. Likewise the stem girth and vegetative growth of moringa increased on application of poultry manure. The overall nutrient attributes of the plant remains same albeit nutrient variability. This makes moringa viable as a potential nutraceutical anywhere in the world as suggested by (Razis *et al.*, 2014).

According to Mbikay (2012) the immature pods of moringa contain around 46.78% fiber and around 20.66% protein content. Pods have 30% of amino acid content, the leaves have 44% and flowers have 31%. The immature pods and flowers showed similar amounts of palmitic, linolenic, linoleic and oleic acids. Moringa has lot of minerals that are essential for growth and development among which, calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300–400 mg, moringa leaves can provide 1000 mg and moringa powder can provide more than 4000 mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while moringa leaf powder has 28 mg of iron. It has been reported that moringa contains more iron than spinach. A good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. M. oleifera leaves show around 25.5–31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet

The difference in results can be attributed to the fact that the location, climate and the environmental factors significantly influence nutrient content of the tree (Foidi *et al.*, 2010). Most plants lose their nutritive properties when processed. When compared, the nutritive content of raw, germinated and fermented moringa seed flour, it was found that phytochemicals were higher in raw seed flour and amino acid content was at its peak in fermented and germinated seed flour. This can be a result of the biochemical activities during germination and microbial activity during fermentation. However, a study reviewed the effect of boiling, simmering and blanching to see the retention of nutrient content of moringa leaves. Interestingly, boiling was the most effective of all the techniques as it reduced the cyanide, oxalate and phytate contents, more significantly than the other two methods. The presence of phytate and other anti-nutrients can reduce the bioavailability of certain nutrients and processing can hence be done for maximum utilization of required nutrients from the seeds and leaves. Evison *et al.*, (2015) reported that boiling increased the availability of iron and antioxidant content. Hence, the processed moringa seed flour can be used to treat malnutrition problems.

Methods of Preserving Moringa

Moringa can be preserved for a long time without loss of nutrients. Drying or freezing can be done to store the leaves. A report by Evison *et al.*, (2015) shows that a low temperature oven used to dehydrate the leaves retained more nutrients except vitamin C than freeze-dried leaves. Hence, drying can be done using economical household appliance like stove to retain a continuous supply of nutrients in the leaves. Preservation by dehydration improves the shelf life of Moringa without change in nutritional value. An overdose of moringa may cause high accumulation of iron. High iron can cause gastrointestinal distress and hemochromatosis. Hence, a daily dose of 70g of moringa is suggested to be good and prevents over accumulation of nutrients.

Nutritive properties

Atli (2015) is of the opinion that every part of *M. oleifera* is a storehouse of important nutrients and anti-nutrients. The leaves of M. oleifera are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper. Vitamins like beta-carotene of vitamin A, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in M. oleifera. Phytochemicals such as tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugar present along with anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate. Moringa leaves also have a lowcalorific value and can be used in the diet of the obese. The pods are fibrous and are valuable to treat digestive problems and thwart colon cancer. A research shows that noodles had a better effect on the mammary glands of rats and improved milk production. The effect of sautéing on the noodles improved lactogogum values, because the oil used was rich in sterols. M. oleifera have also been incorporated into chocolates. Odee (2008) in his report tested

different percentages of moringa in the chocolate fortification and found that, 20% moringa incorporation in cocoa powder was ideal. Studies have shown the potential for developing protein and minerals-rich chocolate. Several such moringa fortifications are possible to ensure intake of adequate amounts of nutrients in children. The effect of moringa on diseases like diabetes and cancer are reviewed.

Table 1: The nutrient compositions of leaves, leaf powder, seeds and pods

Nutrients	Fresh Leaves	Dry Leaves	Leaf Powder	Seed	Pods
Calories (cal)	92	329	205	0.19	26
Protein (g)	6.7	29.4	27.1	0.03	2.5
Fats (g)	1.7	5.2	2.3	0.12	0.1
Carbohydrates (g)	12.5	41.2	38.2	0.03	3.7
Fiber (g)	0.9	12.5	19.2	0.05	4.8
Vitamin B1 (mg)	0.06	2.02	2.64	0.06	0.05
Vitamin B2 (mg)	0.05	21.3	20.5	0.2	0.07
Vitamin B3 (Mg)	0.8	7.6	8.2	0.17	0.2
Vitamin C (mg)	220	15.8	17.3	4.41	120
Vitamin E (mg)	448	10.8	113	45	-
Calcium (mg)	440	2185	2003	8.60	30
Magnesium (mg)	42	448	368	75	24
Phosphorus (mg)	70	252	204	-	110
Potassium (mg)	259	1236	1324	0.15	259
Copper (mg)	0.07	0.49	0.57	-	3.1
Iron (mg)	0.85	25.6	28.2	0.05	5.3
Sulphur (mg)	-	-	870	-	137

All Values are in 100mg per plant nutrients **Source:** Adopted from Bashir *et al.,* 2014

Economic Potentials of Components of Moringa Plant

1. Leaves

Moringa leaves treat asthma, hyperglycemia, Dyslipidemia, flu, heart burns,syphilis, malaria, pneumonia, diarrhea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections. Also reduces, blood pressure and cholesterol and acts as an anticancer, antimicrobial, Antioxidant, antidiabetic and anti-atherosclerotic agents, neuroprotectant (Bashir *et al.*, 2014)

Moringa leaves contain fiber, fat 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 Arginine, Histidine, Lysine, Trypsin, Phenolylinine, Thripcine, Leucine, Meteonine, and Valine are present. Phytochemicals like tannins, sterols, saponins, trepenoids, phenolics, alkaloids and flavanoids like quercitin, isoquercitin, kaemfericitin, isothiocyanates and glycoside compounds are present (Williams *et al.*, 2013).

According to Nambiar *et al.,* (2010) the presence of flavonoids gives leaves the antidiabetic and antioxidant properties. The isothiocyanates are anticancer agents. Flavonoids like quercitin and others are known for anti-proliferative, anticancer agent. The presence of minerals and vitamins help in boosting the immune system and cure a myriad of diseases.

2. Seeds Seeds of Moringa

Help in treating hyperthyroidism, Chrohn'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 are present in the seeds. The presence of flavanoids gives its anti-inflammatory property. The antibiotic pterygospermin is responsible for antimicrobial properties (Morton, 2019). The other phyto-chemicals help in treating various diseases.

3. 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 anti-ulcer, a cardiac stimulant and helps to relax the muscles.

4. Flower Moringa

Flowers act as hypocholesterolemic, anti-arthritic 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.

5. Pods Moringa

Pods treat diarrhea, liver and spleen problems, and joint pain. Pods are 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 in pods.

Medicinal Potentials of *Moringa oleifera*

Anti-diabetic properties

Thumber and Fahey (2009) found out that moringa has the efficacy to cure both Type 1 and Type 2 diabetes. Type 1 diabetes is one where the patients suffer from non-production of insulin, which is a hormone that maintains the blood glucose level at the required normal value. Type 2 diabetes is one associated with insulin resistance. Type 2 diabetes might also be due to Beta cell dysfunction, which fails to sense glucose levels, hence reduces the signaling to insulin, resulting in high blood glucose levels. Several studies have shown that, moringa can act as an anti-diabetic agent. A study has shown that the aqueous extracts of M. oleifera can cure streptozotocin induced Type 1 diabetes and also insulin resistant Type 2 diabetes in rats.

Diabetes leads to several complications such as retinopathy, nephropathy and atherosclerosis etc. Moringa can be used to prevent such ailments. When there is hyperglycemia, the blood glucose reacts with proteins and causes advanced glycated end products (AGEs) (Makker and Becker 2017).

Anti-cancer properties

Cancer is a common disease and one in seven deaths is attributed due to improper medication. Around 2.4 million cases are prevalent in Nigeria, while there are no specific reasons for cancer to develop. Several factors like smoking, lack of exercise and radiation exposure can lead to the disease. Cancer treatments like surgery, chemotherapy and radiation are expensive and have side effects. *M. oleifera* can be used as an anticancer agent as it is natural, reliable and safe, at established concentrations. Studies have shown that moringa can be used as an anti-neoproliferative agent, thereby inhibiting the growth of cancer cells. Soluble and solvent extracts of leaves have been proven effective as anti-cancer agents. Furthermore, research papers suggest that the anti-proliferative effect of cancer may be due to its ability to induce reactive oxygen species in the cancer cells. Researches show that the reactive oxygen species induced in the cells leads to apoptosis (Mbikay, 2012).

Anti-cancer agents targeting cancer using ROS induction are common, but these substances should also be able to attack the antioxidant enzymes. However, Moringa leaf extracts have been shown to be antioxidants and anticancer agents which induce ROS. The exact behavior of the two contrary attributes of the leaves is yet to be explored. The compounds of the leaves that are held responsible for the anticancer activities are glucosinolates, niazimicin and benzyl isothiocyanate. Benzyl isothiocyanate has been shown to be linked with cancer as shown by (Razis *et al.*, 2014).

General Medicinal Uses of *Moringa oleifera*:

Moringa oleifera is a small tree that is native to North India. It passes by an assortment of names, for example, drumstick tree, horse radish tree, miracle tree or ben oil tree. All parts of the *M. oleifera* tree can be eaten or utilized as ingredients as a part of customary home grown drugs. The leaves and pods are commonly eaten in parts of India and Africa as stated. Around the world every part of the Moringa tree has been used effectively against varying ailments. The leaves rubbed against the temple can relieve headaches. To stop breeding from a shallow cut, apply a poultice of fresh leaves, there is an antibacterial and anti-inflammatory effect when applied to wound or insect bite. Extracts can be used against bacterial or fungal skin complaints. Eating Moringa as food product is a good for those suffering from malnutrition due to the high protein and fiber content. The bark is boiled with potash to treat toothache and the seeds are grinded and taken orally for (H.I.V). The seeds are used for their antibiotic and anti-inflammatory properties to treat arthritis, rheumatism, gout, cramp, sexually transmitted diseases and boils. The seed are roasted, pounded, mixed with coconut oil and applied to the problem area. Seed oil can be used for the same ailments (Bashir *et al.*, 2014).

General Uses of *Moringa oleifera* (Drum Stick or Miracle Tree)

Human consumption

Odee (2008) lamented that *Moringa oleifera* tree has probably been one of the most underutilized tropical crops. Leaves of *M. oleifera* could serve as a valuable source of nutrient for all age groups. In some parts of the world for example Senegal and Haiti, health workers have been treated malnutrition in small children, pregnant and nursing women with *M. oleifera* leaves powder. The leaves are known as a great source of vitamins and minerals being served raw, when cooked or dries. Fuglie (2018) reported that 8g serving of dried leaves powder will satisfy a child within age of 13 years with 14% of the protein, 40% of the calcium, 23% of the iron, and nearly all the vitamins that the child needs in a day. 100g of leaves could provide women with over a third of her daily need of calcium and give her important quantities of iron, protein, copper, sulphur and vitamin B. Flowers can be cooked and mixed with other food or fried in butter. They can also be placed in hot water for five minutes to make a kind of tea for drinking. They are also a good source of nectar for honey producing bees. The pod can be eaten from the time they first appear to when they become too woody to snap easily (up to 30cm long). They are cooked like other green beans and have a similar flavour to asparagus. Price (2000) posits that the root is

medicinal and similar to horseradish source can be made from the roots when the seedling is only 60cm tall. The root bark should be completely removed as it contains harmful substances, the root is grinded up and vinegar salt is added. The leaves of M. oleifera are rich and are of high nutritional values.

Economic Uses

Moringa oleifera seeds contain between 30-42% oil and the press-cake obtained as a by-product of the oil extraction process contains a very high level of proteins, some of these proteins (approximately 1%) are active cationic polyelectrolyte's, having molecular weight between 7-17 Daltons (Foidi *et al.,* 2010). The cationic polyelectrolyte neutralizes the colloids in moody or dirty water since the majority of these colloids have a negative electric charge. This protein can therefore be used as a non-toxic natural polypeptide for sedimentary mineral particles and organics in the purification of drinking water, for cleaning vegetable, oil, or for sedimentary fibers in the juice and beer industries. The properties of the natural polypeptide produced from the seeds of Moringa have been known for many centuries in china with the colonization of India by British, this knowledge was effective dispersed to the rest of the world. It has been employed with particular effectiveness in both Egypt and Sudan for cleaning water from Nile specifically for human consumption. Investigations have been conducted using seeds from Moringa for the final treatment in waste water treatment units. In oxidation lagoons, 80% of the oxygen demand of water is caused by unicellular algae. These algae also contain between 40-60% of the nitrogen and phosphorus found in the pre treated waste water. To avoid eutrophication of rivers or lakes by the release of high loads of both phosphorus and nitrogen, the seed can be used to coagulate algae and remove it by this treatment. The seeds are usually used as anticoagulant. Harvested dry seeds are shelled and crushed in to powdered form and made it in to paste with the water before mixing with more water. The mixed water is then allowed to be settled and sieved or use as turbidity which can extensively reduce hardness of water as discussed by (Williams *et al.,* 2013).

Agricultural Uses

Fertilizer can be produced from the seed cake, which is produced by processing the seeds to extract oil, the cake cannot be eaten as it contains harmful substances. However, it contains high levels of proteins and makes a good fertilizer for use in agriculture (Muyibi and Evison 2009). Using Moringa shoot as a green manure can significantly enrich agricultural and in this process, the land is first tilled. Moringa seed is then planted 2cm deep at a spacing of l0 x l0 cm (a density of 1 million seeds per hectare). The density can be greater, the only limit to plant density is the availability of seed, water and fertilizer, after 25 days. The seedlings are ploughed in to the soil to a depth of 15 cm and then prepared for the desired crop. Moringa has a large tap root and few lateral roots so it will not compete for nutrients with the crops, it will also add to the nutrients available as it produces many protein rich leaves. They grow very quickly but do not provide too much shade due to the structure of their leaves. They are also very good as reclaiming, marginal land as stated by (Fuglie 1999).

Fuel wood and other uses, the wood is light, but provides a fairly good fuel for cooking, it has density of 0.5 to 0.7 and yield approximately 4,600kcal/kg. However, it is not suitable for building; the bark fiber is used in making rope, mats and the wood produce a blue dye, chipping of wood can be used to make a good quality paper, the trees also produce viscose resin that are used in the textile industries.

Plant Growth Hormones

Plant hormones (also known as phytohormones) are chemicals that regulate plants growth. Plants hormones are signal molecules produced within the plant and occur in extremely low concentrations. Hormones also determines the formation of flowering, stem, leaves, the shedding of leaves and the development and ripening of fruits etc. Hormone is derived from Greek and means set in motion" plant hormone affects gene expression and transcription levels, cellular division and growth. They are naturally produced within plants, similar chemicals are produced by fungi and bacteria that can also affect plant growth. A large number of related chemical compounds are synthesized by humans; they are used to regulate the growth of cultivated plants. These man made compounds are called plants growth hormone regulators. Hormones are transported within the plant by utilizing four (4) types of movements for localized movements. Cytoplasmic streaming within cells and slow diffusion of ions and molecules between the cells are utilized. Vascular tissues are used to move hormones from one part of the plant to another (Evison *et al*., 2015).

Application Growth hormones

Are well known to promote uniform growth through the cell enlargement. They cause plant to grow, affect flowering, stimulate seed germination, leaf formation etc. The extract obtained from the leaves of Moringa in 80% ethanol contains growth enhancing principle called zeatin (i.e hormone of the cytokinin type). The extract can be used in the form of a foliar spray to accelerate the growth of young plants, use of the growth hormone spray will also cause the plant to be firmer and more resistance to pest and disease. Spraying the leaves of the plant with the Moringa extract diluted with distilled water produced some notable effect such as longer, more vigorous life span, heavier roots, stems and leaves, bigger fruits (Makker and Becker 2017).

Sources of growth hormones

Fuglie (1999) pointed out that although several types of growth hormones are naturally produced within plant, similar chemicals are produced by fungi and bacteria that can also affect plant growth. Juice from „fresh Moringa leaves can be used to produce effective growth hormones, increasing yield by 25-30% for nearly any group of plants (maize, bell pepper, tomato, soya, onion, sorghum, tea, coffee, melon and chili). One of the active substances is zeatin: a plant hormone from cytokinin group. This foliar spray should be used in addition to other fertilizer, watering and found agricultural practice. In one fruit, the use of this hormone (spray) increase maize yield from 60- 13 sacks per hectare.

Human Studies

A single dose research work with six type 2 diabetic cases, feeding of 50- 60 g of a *M. oleifera* leaf powder with a standard meal on a one-time basis reduced glucose levels of blood by 21%. The decreased glucose response of blood to *M. oleifera* was not because of changes in the secretion of insulin. Muyiba and Evison (2009) Studied the anti-dyslipidemic effects of *M. oleifera* in 35 type 2 diabetic cases. The experimental group has received 4.6 g of a *M. oleifera* leaf powder in a tablet form on daily basis for 50 days. It was compared with another group (control), the experimental cases experienced around 1.6% reduction in total plasma cholesterol and a 6.3% reduction in HDL. By comparing this work with the previous works, it can be suggested that the higher doses could be more effective. In a summary form, the previous human researches have indicated that leaf powders of drumstick tree when given orally poses a significant antioxidant, anti-dyslipidemic, and anti-hyperglycemic effects in human cases without producing an adverse effects.

Animal and In Vitro Studies

A number of animal researches have been carried out involving the use of *M. oleifera* aqueous and aqueous alcohol extracts and leaf powder. These researches have exhibited the properties like anti-dyslipidemic, anti-hyperglycemic,antioxidant, immunomodulatory, tissue chemoprotectant, radioprotective, and antihyperglycemic antihypertensive effects. Ethanol extract of drumstick tree leaf is effective in protecting against chromium-induced testicular toxicity in animals like rats. After the extract is administered orally daily (500 mg/kg) for two months to rats that received 8-mg of potassium chromate on daily basis, this extract significantly ameliorated the testicular chromium effects on local immunity, inflammatory markers, and antioxidant enzyme activities and sperm parameters (Odee, 2008).

Commercial applications of Moringa

- Moringa seeds are used to extract oil called the Ben oil. This oil is rich in oleic acid, tocopherols and sterols. It can also withstand oxidative rancidity. The oil can be used in cooking as a substitute for olive oil, as perfumes and also for lubrication. The pods can absorb organic pollutants and pesticides (Atli, 2015).
- Moringa seeds also have great coagulant properties and can precipitate organics and mineral particulates out of a solution. Chemical coagulants such as aluminum sulfate (Alum) and ferric sulfate or polymers removes suspended particles in waste water by neutralizing the electrical charges of particles in the water to form flocs making particles filterable. *M. oleifera* seed is a natural coagulant, containing a cationic protein that can clarify turbid water. This property of M. oleifera seeds is attracting much research as other coagulants such as alum, activated carbon and ferric chloride are expensive and rare. Moringa seed extract has the ability to eliminate heavy metals (such as lead, copper, cadmium, chromium and arsenic) from water. *M. oleifera* functionalized with magnetic nanoparticles such as iron oxide were found beneficial in surface water treatment by lowering settling time. Seed extracts have antimicrobial properties that inhibit bacterial growth, which implies preventing waterborne diseases. These properties of *M. oleifera* seeds have wide applicability in averting diseases and can enhance the quality of life in rural communities as it is highly abundant. Moringa seeds can be used in cosmetics and are sources of biodiesel while the seedcakes, can be used as a green manure or a fertilizer.
- The flowers of moringa are used to make tea with hypocholesterolemic properties. Moringa flowers are said to taste like mushrooms when fried. The moringa flowers are great sources of nectar and are used by beekeepers (Morton, 2019).
- The root bark has medicinal values and is used for dyspepsia, eye diseases and heart complaints.
- The tap root of Moringa is used as a spice.
- The gum from the tree can be used in calicoprinting. The gum and roots also have antibacterial, antifungal and anti-inflammatory properties. The growth hormone from the leaves, called Zeatin is an excellent foliar and can increase the crop yield by 25%–30%.
- Incorporation and fortification of moringa can be significant to tackle nutrient deficiencies and malnutrition. Studies have tried fortifying moringa in snacks.
- Moringa can be used as a fortificant to produce creams and butter crackers. When moringa and Ipomoea batatas as are used concurrently as fortificants, additional nutrients could be added to snacks. The sensory evaluation proved the cream crackers to be widely accepted. *M. oleifera* leaves can be incorporated in the diet of hens and layers thereby providing excellent protein source,

substituting other expensive ingredients such as soybean meal and groundnut cake (Bashir *et al.*,2014). Considering the views of several such fortifications, it is suggested that such addition can be done to other snacks as well. Addition of moringa to the snacks can add nutritive value to the snacks. Most snacks are made up of corn meal and several studies demonstrated that a little addition of moringa to maize flour can add nutritive value to the snack in terms of protein, energy and minerals.

CONCLUSION

Moringa oleifera leaves, flowers, stems, roots, pods or other plant organs exhibit a wide kind of pharmacological and physiological activities. Researches in human have used powdered leaf preparations, while those of animal's studies were based on using hydro alcohol, alcohol (methanol or ethanol) and aqueous extracts of *M. oleifera* leaves and other plant organs to determine the antidiabetic, antioxidant, chemo protective and anti-dyslipidemia effects of *M. oleifera*. It is a tree with diverse potentialities that can be consumed as food or process into other forms to be used in different areas. There is need to study the standardized extracts of *M. oleifera* components to be used in wide range of areas. This study would serve as the background for future studies.

REFERENCES

- Arnarsan, A. (2015). Six science-based health benefit of Moringa oleifera. *Authority Nutrition*, *50*, 372-375.
- Bashir, K. A., Bawa, J. A., & Mohammed, I. (2014). Efficacy of leaf extract of drumstick tree (Moringa oleifera Lam.) on the growth of local tomato (Lycopersicon esculentum). *Journal of Pharmacy and Biological Sciences*, *9*(4), 74-79.
- Oduro, I., Ellis, W. O., & Owusu, D. (2008). Nutritional potential of two leafy vegetables: Moringa oleifera and Ipomoea batatas leaves. *Scientific Research and Essays*, *3*(2), 57-60.
- Foidi, N., Makkar, H. P. S., & Becker, K. (2001). The potential of Moringa oleifera for Agricultural and Industrial uses. *Dar Es Salaam Journal of Science*, Pp. 25-45.
- Fuglie, L. J. (1999). The Miracle Tree. Moringa oleifera: Natural Nutrition for the Tropics. Church World Service. Daka Senegal., Pp.63.
- Makker, H. P. S., & Becker, K. (2017). Nutrient and quality factor in different morphological parts of the Moringa oleifera tree. *Journal of Agricultural Science Cambridge*, Pp.12.
- Mbikay, M. (2012). Therapeutic potential of Moringa oleifera leaves in chronic hyperglycemia and dyslipidemia: A Review Front Pharmacology, Pp 24.
- Morton, J. F. (2019) The Horseradish tree Moringa Ptercygcos Perma (Moringaceae). A Book to Arid Land. *Economic Botany*, Pp.18-33
- Muyibi, S. A., & Evison, L. M. (2009). Optimizing physical parameters affecting coagulation of turbidity waters with Moringa oleifera seeds. *Water Research*, Pp.29.
- Nambiar, S., Guin, P., Parnami, S., & Daniel, M. (2010). Impact of antioxidants from drumstick leaves on the lipid profile of hyperlipidemics. *Journal of Herb Medical Toxicology*, Pp. 165–172.
- Odee, D. (2008). Forest Biotechnology Research in Dry Lands of Kenya: The Development of Moringa species Dry and Biodiversity, *Journal of Africulture*, Pp.7-8.
- Price, M. L. (2000). The Moringa tree. ECHO Technical! Note. ECHO. Florida. USA. l2pp. http:/!www.echonet.Orgnet.orgtropicalag/Moringa 3.htm.
- Abdull Razis, A. F., Ibrahim, M. D., & Kntayya, S. B. (2014). Health benefits of Moringa oleifera. *Asian pacific journal of cancer prevention*, *15*(20), 8571-8576.
- Thurber, M. D., & Fahey, J. W. (2009). Adoption of Moringa oleifera to combat under-nutrition viewed through the lens of the "Diffusion of Innovations" theory. *Ecology of food and nutrition*, *48*(3), 212-225.
- William, F., Lakshminarayanan, S., & Chegu, H. (1993). Effect of some Indian vegetables on the glucose and insulin response in diabetic subjects. *International Journal of Food Sciences and Nutrition*, *44*(3), 191-195.