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Miracle Tree: A Review on Multi-purposes of *Moringa oleifera* and Its Implication for Climate Change Mitigation

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Abstract

Moringa oleifera is known as "horseradish tree" or "drumstick tree", native to India, is one of the best useful tree and an enormous amount of benefits in the world. Numerous Research reports have appeared in different national and international scientific journals by studying its nutritional and medicinal properties of *Moringa* over the past decades. Different reports show that due to its multipurpose uses *Moringa* tree has recently grown attention in Ethiopia. *Moringa oleifera* is a tree that is sometimes called a "Miracle Tree" because of all its parts are used for nutritional, pharmacological properties. *Moringa* is a very valuable food crop (it is highly nutritive, grows very fast and drought resistant) and even beyond food it serves many benefits in developing countries such as having an ability to be used for some crafts (due to being a tree) and cleaning water. The *Moringa* tree can also play an important role in soil and water conservation and mitigating climate change. This study provides a brief overview about multipurpose of *Moringa oleifera tree* and its implication for climate Change mitigation. The purpose of this brief reviews was to: (a) to assess the published scientific journals suggestion on multipurpose *Moringa oleifera,* (b) to over view its medicinal and nutritional properties (c) suggest future directions for policies, research, market and development strategies and (d) finally to review its implication for climate change mitigation.

Keywords: *Moringa oleifera;* Multipurpose; Nutrient content; Medicinal use; Climate change mitigation

Introduction

The background for this study is based on previous study results in Ethiopia and as well as in other countries. *Moringa oleifera* is native to India but it is widely grown tree in Ethiopia, Pacific Islands, Florida, Sudan Caribbean, Philippines, South Africa, Asia, and Latin America [1]. *Moringa* has different names in different countries like "Shiferaw" in Ethiopia and drumstick tree or horseradish tree in India.

As reported Arora et al. [2] there were about 33 species of Moringaceae family. *Moringa oleifera* is one of the moringaceae families. Among those, best known of the thirteen species namely: *M. arborea, M. borziana, M. concanensis, M. drouhardi, M. hildebrandtii, M. longituba, M. oleifera, M. ovalifolia, M. peregrina, M. pygmaea, M. rivae, M. ruspoliana, M. stenopetala* are well known and found worldwide. Numerous studies have reported its multipurpose use like medicinal and nutritional benefits [3,4].

Moringa tree is a drought-tolerant, fast-growing, multi-purpose and one of most useful tree due to its medicinal and nutritional properties in world and therefore described as a 'miracle tree' [5-8]. *Moringa oleifera* is the most promising tree which has used for nutritional benefits, medicinal properties, environmental conservation, and consumption and is the perennial, multipurpose. *Moringa oleifera* is reputedly known as "cabbage tree", "drumstick tree" or "horseradish tree", 'ben-oil tree' or 'benzoil tree', 'miracle tree' and 'mother's best friend tree' [9]. As reported by different scholars *Moringa oleifera has* wide range of uses. Among those, water purification, human consumption, medicine, fuel wood, dye, soil and water conservation, livestock forage and green manure [10-14]. According to Dawit et al. [15] *Moringa* has multipurpose use, well adapted and significant economic importance, as it has vital nutritional, industrial, and medicinal applications.

As reported by researchers in different countries, all parts of *Moringa oleifera* (leaves, fruits, immature pods, and flowers) are combined into the traditional food for human consumption [16,17]. According to Anhwange et al. [18] in many parts of the Africa use *Moringa oleifera* as a food. For example, dried *Moringa* leaves and fresh *Moringa* are involved in meals in countries such as Ethiopia, Nigeria, Malawi East Africa and Ghana used as food.

Numerous research reports have shown the multipurpose uses of most parts of *Moringa oleifera* in making food for human consumptions such as cake by Kolawole et al. [19], yoghurt [20-22], amla, [23,24], weaning foods by Arise et al. [25], bread Chinma et al. [26], soups [27,28], and biscuits by Alam et al. [29],

The seed of *Moringa oleifera* is also used for water treatment as water purification and remove bacteria from water up to 99% as indicated [30,31]. According to Foidl et al. [30] from the *Moringa* fresh leaves a juice can be extracted and used as a growth hormone that can increase yields of crop by 25-35%.

As indicated by Amaglo [32], famine is connected to climate change and therefore planting trees, which can sequester more carbon like *Moringa* tree, can play important role in climate change mitigation. The There is an urgent need to implement climate -smart policies that can build more resilient food systems and combat climate change. There is great potential for the *Moringa* tree to not only store carbon, if it is grown on a much larger scale, but to improve the livelihoods of many farmers in sub-Saharan Africa [33].

The objective of this study was to review a multipurpose uses of *Moringa oleifera* and its implication for climate change mitigation.

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Nutrient contents of *Moringa oleifera*

The most amazing fact about *Moringa* is that it is a storehouse of nutrients and medicinal chemicals. As it was reported by different scholars [34,35], *Moringa* tree is rich in nutrients such as minerals, fiber and proteins that can play essential role in human nutritional consumption. Numerous of the research reports have shown that *Moringa oleifera* leaves has high protein compared to with other leaves eaten as food.

A recent research on dietary iron supplements and *Moringa oleifera* leaves influence the liver revealed that iron from *Moringa oleifera* can overcome iron deficiency [36] and Similarly, research done on the relative bioavailability of folate from the traditional food plant *Moringa oleifera* indicate that the relative bioavailability of folate from *Moringa oleifera* leaves using rat model was very high and therefore *Moringa oleifera* leaves can be a potential source of dietary folate [37].

According to Villafuerte and Villafurte-Abonal [31] research reports, *Moringa* contains full of vitamins and nutrients and therefore it is good to have as food for human consumption and as food for animal's consumption. Also it was reported that seeds *Moringa* contain about between 30-40% oil, 82% unsaturated fatty acids and 13% saturate fats [31].

Numerous research reports on the medicinal and nutritional of *Moringa oleifera* now are existent in scientific journals and the widespread literature. *Moringa* use as medicinal and nutritional purposes was started since centuries Mahmood et al. [38]. *Moringa oleifera* contains all the essential medicinal and nutritional properties and an extremely valuable food source that are vital for human and livestock consumptions [38,39-44]. Study on the potential uses of *Moringa oleifera by* Rockwood et al. [45] show that, *Moringa* contain nutritional value and can be used as bread, milk, spices juices, sauces, tea and *Moringa oleifera* is a wonderful food tree with a significant source of vitamin C, calcium, proteins and Iron. Research report by Rockwood et al. [45] confirmed that, *Moringa oleifera* dry leaves of contain 9 times proteins than yogurt, 10 times vitamin A than carrot, 25 times iron than spinach, 15 times potassium than bananas, 17 times calcium than milk and 7 times more vitamin C than orange. Because of rich in proteins source *Moringa oleifera* leaves are suggested by doctors, nutritionists and community health workers to cope with the problems of malnutrition worldwide [43,46,47]. As different research reports shown that, from the *Moringa* tree parts, *Moringa* leaves are a storehouse of nutrients. The leaves of *Moringa oleifera* are rich in minerals like copper, potassium, iron, magnesium, zinc and calcium [48]. 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 *Moringa oleifera* [49]. Also Yameogo et al. [50] reported that, on a dry matter basis, *Moringa oleifera* leaves contained 27.2% protein, 17.1% fat, 5.9% moisture and 38.6% carbohydrates. According to Anwar and Rashid, [51] noticed that on a dry matter basis, *Moringa oleifera* seeds contained 34.80% ether extract, 31.65% protein, 7.54% fiber, 8.90% moisture, and 6.53% ash contents. Makkar and Becker [52].

Moringa leaves contain fiber, fat proteins and minerals like Mg, Ca, K, P, Fe, Cu, 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 His, Arg, Trp, Lys, Thr, Phe, Leu, Ile, Met, Val are present. Phytochemicals like sterols, tannins, trepenoids, saponins, alkaloids, phenolics and flavonoids like isoquercitin, isothiocyanates, quercitin, kaemfericitin, and glycoside compounds are present [45,49,53-56]

Moringa seed contains antibiotic (pterygospermin), fatty acids like linolenic acid, Linoleic acid, behenic acid and oleic acid (Ben oil); Phytochemicals like saponin, tannins, phytate, phenolics, terpenoids, flavonoids and lectins. Apart from these it contains, fiber, fats, minerals, proteins, and vitamins like A, B, C and amino acids [45,47,49,57,58]. The *Moringa* pods rich in lipids, fiber, non-structural carbohydrates, ash and protein. It also contain fatty acids like linoleic acid, oleic acid, palmitic acid and linoleic acid are also present [45,47].

Benefits/uses of *Moringa*

There are many uses of *Moringa* tree and these will all be: medicines, Human food, Water purification, Animal fodder, Alley cropping, Fertilizer, Living fence, Living fence, Domestic cleaning agent, Fuel wood and other uses. *Moringa* increased physical energy - Tune your body up with naturally occurring nutrients to make your energy last longer. Numerous research reports reveal that, parts of *Moringa* plant can be used in different techniques. *Moringa oleifera* seed and leaves is advantageous source of nutrients, medicines, clean dirty water and it can be used for alley cropping; because, it has lots of leafy material. The uses *Moringa oleifera* are well documented by Fahey [1], as nutritional, industrial, medicinal, and agricultural advantage

Moringa oleifera has great potential for prevention of different diseases like nutrient deficiency, cancer, anemia as well as for dirty water purification. *Moringa* powder contains sufficient amount of vitamins, nutrients and chemicals in it. This makes the tree a medicine for many different diseases [33]. *Moringa oleifera* has also promoted by World Health Organization (WHO) as an alternative to imported food source to treat malnutrition [59].

Medicinal benefits/uses of *Moringa*

Moringa has long been used in herbal medicine by Africans and Indians. *Moringa oleifera* is often referred as a panacea and can be used to cure more than 300 diseases. In this section, medicinal uses of *Moringa* leaves are reviewed. Different studies shown that, all parts of *Moringa oleifera* (leaves, fruits, immature pods, and flowers) are incorporated into the traditional food of humans in many tropical and subtropical countries.

Medicinal uses of all parts of *Moringa*

Various parts of *Moringa* tree act as cardiac and possess antitumor, circulatory stimulants, antiepileptic, antipyretic, antiulcer, anti-inflammatory, antispasmodic, anti-hypertensive, diuretic, antioxidant, anti-diabetic, cholesterol lowering, antibacterial, hepatoprotective and antifungal activities.

Leaves: *Moringa* leaves are the most commonly used part of the plant. *Moringa* leaves treat hyperglycemia, asthma, flu, heart burn, Dyslipidemia, malaria, syphilis, diarrhea, pneumonia, scurvy, headaches, bronchitis, skin diseases, eye and ear infections. Also reduces, blood pressure and cholesterol and acts as an anticancer, Antioxidant, antimicrobial, anti-atherosclerotic and ant diabetic agents, neuro protectant [45,49,53-56].

Seeds: Numerous researches reported that, *Moringa* seed powder can be used as for cleaning dirty water in a simple and quick method. Seeds of *Moringa* help in treating Chrohn's disease, hyperthyroidism, rheumatism, antiherpes-simplex virus arthritis, cramp, epilepsy gout, and sexually transmitted diseases, can act as antimicrobial and anti-inflammatory agents [45,47,48,57,58].

Root: Root bark acts as an anti-ulcer, anti-inflammatory and cardiac stimulant agent [55,60,61].

Flower: Many scholars shown that *Moringa* flowers act as anti-arthritic; hypocholesterolemic agents can cure urinary and cold problems [53,58].

Pods: *Moringa* pods treat liver, diarrhea and spleen problems, and joint pain [45,48].

Animal feed fortification: Study on the potential of *Moringa oleifera* for agricultural and industrial uses and on the naturalized exotic tree species shown that, *Moringa* leaves supplementary to livestock feed can increase up to 32% of daily weight gain. Supplementation of fresh *Moringa* leaves with 15 to 17 kg of daily feed of livestock can increase milk production by 43%. Milk production can be increased by 58% with the supplementation of 2 kg dry matter feed and milk production increased by 65% with the supplementation of 3kg dry matter feed [30,62]. Generally, milk production increased with increased *Moringa* supplementation.

Water purification: The study on the *Moringa oleifera* as a natural gift point out that, A billion people across world like; Latin America Africa, and Asia are assessed to depend on untreated water sources for their daily needs Mahmood et al. [38]. Numerous research reports shown that, *Moringa* seed powdered can be used cleaning dirty water in simple and quick method simple. The *Moring*a seed powder joins with the solids in the dirty water and sinks to the bottom. This action can remove bacteria contained in water up to 90-99%. Rather than using aluminum sulphate, which are dangerous to people and the environment, using *Moringa* seed powder to purify water is cheap. Water can be purified by adding 2 grams of *Moring*a seed powder to 20 liters into a bottle and shake for 5 minutes. Dirty water that is to be treated can be filtered through a clean cloth into the container. Until the water becomes clear and the impurities have sunk to the bottom leave the bucket undisturbed for one hour then filter the water through a clean cloth boil the water before drinking [63-66].

Implications of *Moringa* tree to climate change mitigation

In developing country climate change is affecting to smallholder farmers who dominate the agriculture sector. The study on the opportunities for linking adaptation and mitigation in Agroforestry systems indicated that, the impacts of climate change are handled at the level of natural resource base upon which smallholder farmers depend, at the individual and farming system level Vershot et al. [67]. The research reported on the environmental and medicinal value analysis of *Moringa oleifera* specified that, Farmers need to formulate adaptation strategies and mechanisms to reduce the climate change impacts [33]. To combat efficient for climate change mitigation and food shortages it is good to look at the potential that is already available in developing and third world countries. *Moringa* is therefore a very simple and readily available solution. *Moringa oleifera* is called a “Never Die” plant because of its adaptability to weather, soil and other environmental vagaries according to [41]. There is clear evidence that *Moringa oleifera* is, no doubt, a suitable crop for climate change in Nigeria given its high level of adaptability and numerous nutritional, medicinal, agricultural, domestic and industrial values Ndubuaku et al. [68]. The heavy flushes produced by the trees even during the dry season act as good sink for carbon dioxide absorption and utilization, thus reducing the level of atmospheric carbon dioxide which is one of the major courses of ozone layer depletion and global warming. *Moringa* tree is a climate-change-adaptable crop for life sustenance against food insecurity threats Ndubuaku et al. [68]. Large production of the trees is, therefore, advocated especially amongst the women. It does not only add to the home-use foodstuff but also creates job opportunities for women and their children for their capacity building. It reduces death toll due to malnutrition and diseases Ndubuaku et al. [68]. The ability of the tree to mitigate the effects of climate change is also impressive. According to the study [31] the rate of *Moringa* tree to absorb carbon dioxide (CO_2) is fifty times (50x) higher when compared to the Japanese cedar tree and also twenty times (20x) higher than that of general vegetation. Study on *Moringa* and global warming revealed that, 1 person emits 320kg of CO_2/year; it takes 23 Japanese Cedar trees takes 50 years to absorb this amount of CO_2; it takes 2 *Moringa* trees 2 years to absorb this amount and 1 family car emits 2300kg of CO_2/year; it takes 160 Japanese Cedar trees 50 years to absorb this amount of CO_2; it takes 10 *Moringa* trees 2 years [69]. Therefore, *Moringa* tree is useful tool in the prevention of global warming; because it sequesters more carbon with its all parts. Therefore, planting such important tree in different parts of the country will mitigate the impacts of climate change.

Conclusions

Moringa oleifera tree is indeed a miracle tree with enormous potentials yet to be fully explored in medicinal and food application. All parts of *Moringa oleifera* tree is said to have useful assets that can help humankind.

This study has tried to reviews a multipurpose uses of *Moringa oleifera* and suggestion for the future mitigation of climate change. Numerous researchers concluded that, *Moringa oleifera* is a multipurpose tree and fast growing and well adapted to growing in adverse climate conditions and therefore, that is difficult to overlook in today’s battle with the climate. Different studies reveal that, *Moringa* has a direct effect on agriculture, nutrition, health, water, environment, biodiversity and sanitation.

The latest research has documented that, *Moringa oleifera is* one of the medicine to reduce the occurrence of waterborne disease which is on record as one of the main causes leading to high incidence of deaths in the developing countries. Thus, *Moringa oleifera* seeds are capable of appealing and sticking fast to bacteria and viruses that are found in contaminated and turbid water.

The capacity of the *Moringa* tree is inspiring in mitigating the adverse effects of climate change. The research report by Japanese has displayed that the rate of absorption of carbon dioxide (CO_2) by the *Moringa* tree is twenty times (20x) higher than that of general vegetation. There is great potential for the *Moringa* tree to not only store carbon, but also to improve the livelihoods of many smallholder farmers. Therefore, planting of this tree in different parts of the country will mitigate the impacts of climate change.

Moringa oleifera really recognized to be a "Miracle tree", because it has multipurpose use for humankind and thus named as a nature gift at very low price. In order to discover and utilize full uses of this miracle tree, market development strategies, Strong policies, and research were required.

Given its multiple uses and wide range of adaptability, *Moringa* is an ideal crop for sustainable food production that thrives as the climate changes.

Generally, *Moringa oleifera* offers very interesting opportunities for smallholder farmers as food supplement, medicine, nutrition, water treatment, livestock feed, vegetable, oil, foliar spray, green manure, natural fertilizer, cosmetic, fooder, care products, soil and water conservation and reduce greenhouse gas emission.

Moringa should be promoted for further consumption to improve nutrition and medicinal functions and as well as for climate change mitigation.

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