



## VERSATILE USAGE & THERAPEUTIC APPLICABILITY OF MIRACULOUS DRUMSTICK TREE (*MORINGA OLEIFERA*-LAM.)

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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 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. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. *Moringa* has antioxidants which combine with the reactive oxygen species and prevent cell damage and further consequences. In addition to vitamin C,  $\beta$ -carotene, and Quercetin which are powerful antioxidant help lower blood pressure. *Moringa* seeds and leaves could be an effective and safe alternative remedy in sexual disorders. *Moringa* has traditionally been used to boost sexual stamina and desire and to treat male sexual disorders. In more recent times, *Moringa* has gained notoriety as a very nutritious plant that can feed the needy and, in fact, save lives. *Moringa* leaves or leaf powder can be used successfully as a supplement food to nourish small children, pregnant or nursing women, and of course, anybody else. In this paper, versatile uses and therapeutic applicabilities of *Moringa oleifera* have been precisely delineated.

**Keywords:** Lactogogues, Stigmasterol, Sitosterol, Ampesterol, Malnutrition, Hypocholesterolemic, Zeatin.

### INTRODUCTION

*Moringa* is a plant that is native to areas of India, Pakistan, Bangladesh, and Afghanistan. This tree was introduced to Malawi by settlers from India and is still closely associated with the low-altitude areas where they settled. It has been introduced throughout the tropics and subtropics and has become naturalized in many African countries. The cultivation of *moringa* in India occurs mainly in the southern states of Tamil Nadu, Karnataka, Kerala, Andhra Pradesh as well as in central India also. This fast-growing

tree is grown for human food, livestock forage, medicine, dye, composting, and water purification.

Every part of *M. oleifera* is a storehouse of important nutrients and antinutrients. The pods are fibrous and are valuable to treat digestive problems and thwart colon cancer. *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<sup>1-3</sup>.

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In more recent times, Moringa has gained notoriety as a very nutritious plant that can feed the needy and, in fact, save lives. Five human studies using *Moringaoleifera*, have demonstrated anti-hyperglycemic (antidiabetic) and anti-dyslipidemic activities. These activities have been confirmed using extracts as well as leaf powders in animal studies. Standardization of Moringa products is an issue. However, the results of published studies to date involving *Moringaoleifera* are very promising. In ideal conditions *Moringaoleifera* plants can grow several feet in a short time frame.

This ability for quick and substantial growth of the plant are linked to the effects of Zeatin (plant hormones that induce cell division, growth, and delay aging of cells). Zeatin is also linked to anti-aging or the slowing down of aging processes in the human body. Zeatin is a more natural way to support skin health by regenerating new skin cells. When the diet includes these plant nutrients, the body as a whole can fight aging, starting at the cellular level. Found in most plants, Zeatin is more abundant in one plant than any other. *Moringaoleifera* is Zeatin king, in comparison to other plants<sup>4</sup>.



In addition to their essential roles in the growth and development of plants, cytokinins (zeatin) have various effects in man and animals at both cellular and whole organism levels. Hence, cytokinins and their derivatives have many potential therapeutic applications, including possible efficacy in the treatment of proliferative diseases such as cancer<sup>5,6</sup>.

#### **MEDICINAL PROPERTIES & RESEARCH ARENA**

Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its

leaves, pods and seeds. Moringa is said to provide 7x more vitamin C than oranges, 10x more vitamin A than carrots, 17x more calcium than milk 9x more protein than yoghurt, 15x more potassium than bananas and 25x more iron than spinach. Moringa is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones. 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<sup>7</sup>.



PUFAs are linoleic acid, linolenic acid and oleic acid; these PUFAs have the ability to control cholesterol. Research show that Moringa seed oil contains around 76% PUFA, making it ideal for use as a substitute for olive oil. 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. This study aims to bridge the gap. Moringa has been shown 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<sup>8</sup>.

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. In another study, the researchers fed the STZ-induced diabetes rats with Moringa seed powder and noticed that the fasting blood glucose dropped. Also, when the rats were treated with about 500 mg of Moringa seed powder/kg body weight, the antioxidant enzymes increased in the serum. This shows that the antioxidants present in Moringa can bring down the ROS caused in the Beta-cells due to the STZ induction. STZ causes ATP dephosphorylation reactions and helps xanthine oxidase in the formation of superoxides and reactive oxygen species (ROS) in Beta cells. In hyperglycemic patients, the beta cells get destructed<sup>9</sup>.

Therefore, high glucose enters the mitochondria and releases reactive oxygen species. Since beta cells have

low number of antioxidants, this in turn causes apoptosis of the beta cells. This reduces insulin secretion leading to hyperglycemia and in turn diabetes mellitus Type-2. The flavonoids like quercetin and phenolics have been attributed as antioxidants that bring about a scavenging effect on ROS. It can be hypothesized that the flavonoids in Moringa scavenge the ROS released from mitochondria, thereby protecting the beta cells and in turn keeping hyperglycemia under control<sup>10</sup>.

Mechanism of high glucose leading to diabetes and the effect of Moringa on progression of diabetes. The high glucose in blood enters glycolysis in the mitochondria of beta cells and forms reactive oxygen species. This then causes apoptosis of beta cells which in turn leads to decreased insulin secretion, hyperglycemia and finally Type-2 diabetes. However, the cell apoptosis of beta cells can be averted by the use of Moringa. Moringa has antioxidants which combine with the reactive oxygen species and prevent cell damage and further consequences.

Mechanism of diabetes leading to atherosclerosis and effect of m on the progression of atherosclerosis. High blood glucose due to glycolysis releases ROS, which then forms AGEs and LDLs. The LDLs can directly lead to inflammation, while the AGE when combined to RAGE expressed on cell surface, can cause expression of NFk-B. This can further lead to transcription of other cytokines and in turn inflammation. Inflammation causes transendothelial migration of immune cells and LDLs, leading to atherosclerosis. Moringa can prevent atherosclerosis by scavenging ROS and preventing the formation of AGE and LDL, thereby acting as an anti-atherosclerotic agent. Moringa can be used as a potent neuroprotectant. The leaf extracts have shown to decrease the acetylcholine esterase activity, thereby

improving cholinergic function and memory. Researchers showed that Moringa in diet of rats, can increase protein content and decrease levels of urea and creatinine in blood, preventing renal dysfunction.

The antibacterial effects of the seeds were accounted for by the presence of pterygosperrin, moringine and benzyl isothiocyanate. presents nutritional composition and medicinal uses of different parts of Moringa. The Obesity is a condition in which excess body fat is accumulated to an extent that health may be negatively affected. Obesity is associated with a number of chronic health problems such as diabetes, heart disease, hypertension and cancer. Obesity is a major risk factor for augmented morbidity and mortality and is associated with various medical ailments. Further, obesity has been found to be associated with various disorders such as osteoarthritis, ischemic heart diseases (IHD), atherosclerosis, diabetes, and hypertension. Currently, no pharmacological treatment provides sustained weight loss with minimal adverse effects<sup>11</sup>.

Moringa has been clinically proven to increase the production of breast milk whether it is consumed before or after the birth of a baby. For pregnant and breast-feeding women, Moringa leaves and pods can do much to preserve the mother's health and pass on strength to the fetus or nursing child. Several studies demonstrated the lactation-enhancing effect of Moringa leaves as evidenced by a greater increase in maternal serum prolactin levels and percentages of gains in the infants' weights among the lactating mothers who take Moringa leaves. It is therefore recommended its routine use among mothers of preterm infants to augment lactation, thereby ensuring an adequate supply of breast milk in the population that needs it the most<sup>12</sup>.

Moringa seeds and leaves could be an effective and safe alternative remedy in sexual disorders and has traditionally been used to boost sexual stamina and desire and to treat male sexual disorders. Studies confirm traditional believes that Moringaoleifera ingestion may produce increased effects on fertility and reproductive system in adult males. It also lends support to the claims for traditional usage of Moringaoleifera as a sexual function enhancing medicine. Scientific tests in rats, confirms that Moringa improve sexual performance proving this

traditional medicine right. In Siddha medicine, the Moringa is used as a sexual virility drug for treating erectile dysfunction in men and also in women for prolonging sexual activity.

Infertility is one of the major health problems in couples' lives; approximately 30% of couple's infertilities are due to male factors. Several conditions can interfere with spermatogenesis and reduce sperm quality and production. Many factors such as drug treatment, chemotherapy, toxins, air pollution, and insufficient vitamin intake may have harmful effects on spermatogenesis and the normal production of sperm. A large number of plants have been tested throughout the world for the possible fertility regulatory properties. Some medicinal plants are extensively used as aphrodisiac to relieve sexual dysfunction, or as fertility enhancing agents. Moringa provide a boost of nutritional value thereby improving sexual performance and libido. Studies confirm traditional believes that Moringaoleifera ingestion may produce increased effects on fertility and reproductive system in adult males. It also lends support to the claims for traditional usage of Moringaoleifera as a sexual function enhancing medicine<sup>13</sup>.

#### **HIGH ANTIOXIDANT CONTENT IN MORINGA OLEIFERA**

Studies show that the powder from the Moringa tree leaves register a higher ORAC (Oxygen Radical Absorbance Capacity) score than many any other foods. With an ORAC score of 157,000, MoringaOleifera tops other antioxidant superfoods, including Acai berries, green tea, blueberries, dark chocolate, garlic, goji berries, pomegranates, etc. Herbal medicines have a vital role in the prevention and treatment of cancer and medicinal herbs are commonly available and comparatively economical. The Moringaoleifera extract shows high antioxidant activity, potent cancer cell anti-proliferation, and induction of quinone reductase. Further investigation necessary for its use in the cases of clinical anticancer activity. Antimicrobial resistance has become a global problem. Strategies to improve the current situation include research in finding new and innovative antimicrobials. Moringaoleifera leaves contain bio-components whose antibacterial potentials are highly comparable with that of the antibiotic tetracycline. Moringaoleifera could become promising natural antimicrobial agents with potential

applications in pharmaceutical industry for controlling pathogenic bacteria. However, if plant extracts are to be used for medicinal purposes, issues of safety and toxicity will always need to be considered. Study - Antibacterial evaluation of *Moringa Oleifera* 14,15.

Leaves of *Moringaoleifera* is nature's solution to maintaining a hygienic hand. Lab tests have shown that *Moringaoleifera* leaf powder has potential effect as a hand washing product. *Moringaoleifera* could be very useful in places where soap or water is not available, and where this tree grows naturally. It could also be a cheap and healthy hand-washing optional product. Study - *Moringa* as antibacterial hand washing. *Moringa* is a very simple and readily available tool to help prevent malnutrition. It is a drought-resistant and fast growing tree which is present in nearly all tropical and sub-tropical countries. *Moringa* grows best, exactly where it is needed the most

*Moringa* leaves can be produced intensively in a family-size small garden. The seeds can be spaced as closely as ten centimeters apart. When the plants reach a height of a meter, they can be cut down to a height of 30 centimeters. The leaves can be stripped from the stems and used to prepared sauces or dried for long-term storage as a nutritious food additive, and the stems fed to livestock. The stumps survive the harvest and will re-sprout, allowing another harvest in as little as fifty days. Using this technique, a *Moringa* garden can continually produce green matter for several years with very little labor required. See instructions how to build a *Moringa* garden in your backyard 15-17.

A study was designed to evaluate the impact of *Moringaoleifera* in improving the nutritional status of vulnerable groups, including children. The monitoring of severely malnourished children allowed us to objectively assess the impact of *Moringaoleifera* leaf powder consumption on these patients. The study allowed us to appreciate the benefits to nutritional recovery of the *Moringaoleifera* leaf powder, by assessing parameters such as daily weight gain, recovery speed, hemoglobin rate, and side effects. The acceptability of *Moringaoleifera* amongst patients was good. The study shows that *Moringa* is packed with nutritional potential, can be used as a dietary supplement, and may contribute to the fight against malnutrition. Study - Combat malnutrition with *Moringaoleifera* 17,18.

### **Moringa leaves as fodder**

Regular supply of adequate and nutritious feed and fodder is essential for the development of livestock sector. Fodder crops are the main and cheapest source of roughage feed for livestock. However, shortage of quality fodder, particularly during lean periods is major factor contributing to lower livestock productivity. Forage have an important role to play in ruminant nutrition in providing energy, protein and minerals and fiber for chewing. Tree fodders could be a good option to meet the fodder demand of livestock in areas having a perennial shortage of green fodder. Research efforts have confirmed the potentiality of browsing plants to provide alternate source of nutrition for ruminants in tropics. There is a huge list of such browse trees and shrubs with potential use as fodder, which may go even up to more than 300 species. One such tree which gives fodder for ruminants is *Moringa*, popularly known as “drumstick tree” for its pods that are used by drummers, and also known as “horseradish tree” for the flavor of its roots. *Moringa* leaves contain  $\beta$ -carotene, protein, vitamin C, high amount of macronutrients Mg and K, and can be effectively used to fulfill the dietary and nutritional requirements of livestock animals by mixing of *moringa* leaves with other fodders or grasses 19-21. Since *Moringa* leaves are rich in protein, so can be used as a supplemental fodder for milch animals. Rather, its leaves contain much higher protein than conventional protein supplements like coconut meal, cotton seed cake, ground nut cake, sesame cake, sunflower cake etc. Macronutrients like P, K, Ca, and Mg play key roles in balancing the physiological, metabolic, and biochemical processes of livestock. Cattle suffer from low blood Mg during lactation, which causes low milk yield due to deficiency of mg. *Moringa* fresh foliage can be included into the dietary roughage component for ruminants. It has shown positive effects on feeding behavior of goat, increased growth rate in sheep and increased milk yield in dual purpose cows. It improves the milk yield of ruminants as it has a good rumen bypass protein characteristics. In fact, *moringa* leaf meal can be used as a substitute for other oil cakes 22.

### **PROFIT-MAKING APPLICATIONS**

It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. *M. oleifera* seed, a natural coagulant is extensively used in water treatment. The scientific effort of this research provides insights on the use of *Moringa* as a cure for diabetes and cancer and fortification of *Moringa* in commercial products. This review 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”.

A sensory evaluation on cookies made from a mix of maize flour and Moringa seed flour has been carried out.. The flour was mixed with different percentages of the two flours and the best acceptance was for 92.5% maize and 7.5% Moringa seed flour combination. This was well accepted due to its crispness, aroma, taste and color. Cereal gruels have also been fortified by Moringa leaves in order to improve the protein content and energy. The cereal gruel with 65% popcorn and 35% Moringa leaves was blanched and fermented. The fermented ones showed higher protein and energy while the blanched cereal had higher mineral content .Researchers also used Moringa as a fortificant and produced cream and butter crackers with Moringa and Ipomoea batatas as fortificants, with the hope of adding additional nutrients 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 ground nut cake<sup>23</sup>.

Moringaoleifera 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 (~1%) are active cationic polyelectrolyte“s, having molecular weight between 7-17 Daltons. 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 al so contain between 40-60% of the nitrogen and phosphorus found in the pretreated P & N, the seed can be used to coagulate algae and removed by this treatment as mentioned. 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<sup>24</sup>.

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. However, further studies on Moringa as a fortified Indian snack is required before bringing commercialized Moringa to the market.

#### THE SEEDS OF MORINGA OLEIFERA TREE TO PURIFY WATER

Researchers from all around the world agree that Moringa seeds can give a more efficient purification process than conventional synthetic materials in use today. In many countries it is still difficult to obtain clean water. But not only Third World countries can benefit from Moring seeds as a water purifier. Even developed countries can benefit from a process that treats waste water without addition of further synthetic chemicals. Results from studies show that the clusters of material (flocs) that are produced with the protein are much more tightly packed than those formed with conventional



flocculating agents. This is better for water purification as such flocs are more easily separated. Crushed Moringa seeds clarify and purify water to suit domestic use and lower the bacterial concentration in the water making it safe for drinking. 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<sup>25</sup>.

Numerous research reports shown that, Moringa seed powdered can be used cleaning dirty water in simple and quick method simple. The Moringa 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  $Al_2(SO_4)_3$ , 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 Moringa 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.

#### **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. 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. 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. 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<sup>26</sup>.

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. 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. The ability of the tree to mitigate the effects of climate change is also impressive.

According to the study, the rate of Moringa tree to absorb  $CO_2$  is 50x higher when compared to the Japanese cedar tree and also 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. 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<sup>27</sup>.

#### **CONCLUSION**

*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. With its high nutritive values,

every part of the tree is suitable for either nutritional or commercial purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent. *M. oleifera* seed, a natural coagulant is extensively used in water treatment. The scientific effort of this research provides insights on the use of *Moringa* as a cure for diabetes and cancer and fortification of *Moringa* in commercial products. This review 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". The research on *M. oleifera* is yet to gain importance in India. It is essential that the nutrients of this wonder tree are exploited for a variety of purposes. *M. oleifera* has great anti-diabetic and anti-cancer properties. However, double blind researches are less prevalent to further substantiate these properties of *Moringa*. More studies are needed to corroborate the primary mechanisms of *Moringa* as antidiabetic and anticancer agents. Several puzzling questions are unanswered. Research on the antioxidant nature of aqueous extracts on cancer cells needs further inquiry. Studies have proven that *Moringa* causes ROS in cancer cells that leads to apoptosis or necrosis. However, the aqueous extracts also have antioxidants present in them. The exact mechanism of this irony is yet to be explored. The effect of environmental factors affecting the nutrient levels of leaves and other parts of *M. oleifera* grown across the globe require further analysis. Further research to isolate endophytic fungi and identify the enzymes or proteins from *M. oleifera* that are accountable for the anticancer and antidiabetic activity may lead to development of novel therapeutic compounds. Yet another focal area is to evaluate the commercial use of *M. oleifera* as a bio-coagulant. It might be a viable alternative for water purification. The demand for snacks in the market is huge. Hence *Moringa* fortification in snacks to eradicate malnutrition has a twin advantage.

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