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A Review on Nutritional and Medicinal Benefits of Drumstick: A Miracle Vegetable

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Drumsticks, commonly known as Moringa (*Moringa oleifera*), have been held in high esteem in traditional cuisines for their excellent flavour, versatility and nutrition or health packed benefits and may be considered as a miracle vegetable. Drumsticks are rich in vitamins, minerals and antioxidants that work wonders for the body. Every part of this remarkable plant, from the leaves to the pods (called drumsticks), is loaded with nutrients contributing to overall well-being. Adding drumsticks to human diet can bring about a plethora of health benefits due to its rich medicinal value. The leaves, pods and seeds of moringa contain large amounts of phytochemicals and antioxidants which are responsible for its anti-diabetic and anti-cancer properties. Its rich nutritional (vitamins and minerals) profile prevents malnutrition and supports general health and immune

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function. The lower glycine index of drumsticks contributes to well balanced sugar levels in the blood. The rich amounts of calcium and magnesium help strengthen the bones and joints in the body and helps in treating arthritis. The natural compounds present in drumsticks regulate the blood flow, thus ensuring a balanced blood pressure and improved cardiovascular health. Vitamins and minerals present in drumsticks also help support cognitive functions and helps in treatment of dementia. Thus, inclusion of drumsticks in human diet not only spices up the flavours of the dishes but also provides numerous health benefits, making it a versatile and valuable vegetable. However, more research on use of *M. oleifera* is needed to exploit its rich nutritional status as well as its anti-diabetic and anti-cancer properties.

Keywords: Nutrition; drumstick; vegetable; medicinal benefits; health.

1. INTRODUCTION

"Drumsticks refer to the elongated cylindrical pods of Moringa (*Moringa oleifera*), an angiospermic tree belonging to family *Moringaceae*. It is widely grown commercially for its slender pods, called drumsticks, and leaves. The drumsticks containing dark-brown seeds, are commonly used as vegetable. The drumsticks can be termed "Miracle Vegetable" because of their high nutritional and health benefits. It is believed to be originated from sub-Himalayan tracts of the Indian sub-continent but also used extensively in south and south east Asia. The tropical and sub-tropical areas of the world are suitable for the growth of this plant. It is a fast-growing and deep-rooted plant tolerant to drought conditions. India is the largest producer of Moringa with an annual production of 2.2 million tonnes of tender fruits (a productivity of 51 tonnes per ha) from an area of 43600 ha with Andhra Pradesh leading in its production, followed by Karnataka and Tamil Nadu" (Kumar *et al*., 2014).

"Moringa is grown mainly for its tender pods as well as for its leaves and flowers" (Kumar *et al*., 2014). "The leaves, flowers, fruits and immature pods of this tree are used as a highly nutritive vegetable in many countries particularly India, Pakistan, Philippines, Hawaii and many parts of Africa" (D'Souza & Kulkarni, 1993; Anwar *et al*., 2005). It is a useful tree cultivated throughout the tropics and is marketed as a dietary supplement and health food (Jules & Paull, 2008). It is widely cultivated for its young seed pods and leaves which are not only as vegetable but also used in traditional herbal medicines.

2. BOTANICAL DESCRIPTION

"The genus *Moringa* includes 13 species which occur in tropical and subtropical regions of Africa and Asia and range in size from a small shrub to a massive tree. But the most widely cultivated species is *oleifera* which is native to the foothills of the Himalayas in northwestern India" (Olson, 2010). "*Moringa oleifera* is a fast-growing deciduous tree that can attain a height of 10–12 m and trunk diameter of 46 cm. However, in cultivation, it is often cut back annually to 1–2 m and allowed to regrow so that the pods and leaves remain within arm's reach. The leaves are typically pinnately compound with entire margins and are commonly used to make tea. The flowers are hermaphrodite with about 1–1.5 cm in length and 2 cm in width and are surrounded by five unequal, thinly veined and yellowish-white petals. The flowers may be either bilaterally or radially symmetric and generally range in colour from white or creamy to brown" (Olson, 2002). The flowers grow on slender hairy stalks in the form of spreading or drooping clusters, which have a length of 10–25 cm. Flowering usually occurs within first six months of planting. The trees may flower once a year (during April to June) in seasonally cool regions like north India, twice a year in south India or round the year in regions with more constant temperature and rainfall such as in Caribbean regions.

"The fruit or drumstick is a hanging capsule of 20-45 cm length having 15 to 20 dark brown globular seeds of 1 to 1.2 cm diameter. The fruits are typically elongated and slender with longitudinal ridges, resembling an indehiscent silique and are used as vegetable besides being used in traditional medicines" (Ramachandran *et al*, 1980). "The fruits or pods of Moringa are consumed as food in many parts of the world, particularly in South Asia" (Veronica *et al*., 2021). Moringa leaves and soft twigs can also be used as green fodder for livestock like any other perennial multi-cut fodder crops as these are rich sources of nutrients for dairy animals. Oil is obtained from the seeds while the leaves and roots can be used in powdered form (Anwar & Bhanger, 2003).

Table 1. Names of Moringa in different languages

Language	Name
English	Drumstick, Horse radish tree
Hindi	Sahjan, Saguna, Sainjna
Punjabi	Sainjna, Soajna
Sanskrit	Subhanjana
Gujrati	Suragavo
Tamil	Mulaga, Munaga
Malayalam	Murinna, Sigru
Unani	Sahajan
Ayurvedic	Haritashaaka, Raktaka, Akshiva

Moringa is most commonly known as *sahjan* or *sajina* in India. The names of Moringa in various languages as under.

Moringa can be propagated by seeds as well as by stem cuttings. However, seed is the most reliable and quick method for propagation of Moringa crop. In vegetatively propagated plants, first harvesting is expected within 6–8 months after planting, which extends over a year when planting is done through seed. In north India, fruits are harvested once during summer while in South India harvesting can be done twice (July to September and March to April). Besides, moringa can also be grown for livestock fodder (Nouman *et al*., 2014).

Moringa can be termed as a miracle tree due to its exceptional nutritional and medicinal properties which are described here.

3. NUTRITIONAL VALUE

"All parts of moringa plant are rich in nutrients. Leaves are rich in minerals, including Ca, K, Zn, Mg, Fe, and Cu" (Kasolo *et al*., 2010). In addition to it, the leaves also contain beta-carotene, pyridoxine, nicotinic acid, folic acid as well as vitamins C, D, and E (Asiedu- Gyekye *et al*., 2014). "The pods of moringa contain about 46.8% fiber and 20.7% protein with amino acids fairly distributed among pods (30%), leaves (44%) and flowers (31%). Moringa leaves can provide1000 mg of calcium while moringa powder can provide 4000 mg per 100 g" (Gopalakrishnan et al., 2016). "Moringa leaf powder contains 28 mg of iron per 100 g against beef's 2 mg indicating that anaemia may be treated with moringa powder. Iron content of moringa leaves is higher than that in spinach" (Asiedu- Gyekyeet *et al*., 2014). "It is essential to

Table 2. Nutritional profile of various plant parts (per 100 g plant material) of Moringa

Nutrients	Fresh leaves	Dry leaves	Leaf powder	Seeds	Pods
Calories (cal)	92	329	205	–	26
Carbohydrates (g)	12.5	41.2	38.2	8.67 ± 0.12	3.7
Fibre (g)	0.9	12.5	19.2	2.87 ± 0.03	4.8
Protein (g)	6.7	29.4	27.1	35.97 ± 0.19	2.5
Fat (g)	1.7	5.2	2.3	38.67 ± 0.03	0.1
Vitamin B1 (mg)	0.06	2.02	2.64	0.05	0.05
Vitamin B2 (mg)	0.05	21.3	20.5	0.06	0.07
Vitamin B3 (mg)	0.8	7.6	8.2	0.2	0.2
Vitamin C (mg)	220	15.8	17.3	4.5 ± 0.17	120
Vitamin E (mg)	448	10.8	113	751.67 ± 4.41	–
Calcium (mg)	440	2185	2003	45	30
Magnesium (mg)	42	448	368	635 ± 8.66	24
Potassium (mg)	259	1236	1324	–	259
Phosphorus (mg)	70	252	204	75	110
Sulphur (mg)	–	–	870	0.05	137
Copper (mg)	0.07	0.49	0.57	5.20 ± 0.15	3.1
Iron (mg)	0.85	25.6	28.2	–	5.3

Sources: Fuglie, 2005; Olagbemide and Alikwe, 2014; www.moringaleafpowder.co.za/analysis.html

consume zinc in sufficient quantities in order to maintain the proper growth of sperm cells and to synthesize DNA and RNA. The amount of zinc per kilogram of *M. oleifera* leaves ranges between 25.5 and 31.0 mg which is sufficient to meet the daily zinc needs of a person" (Wright *et al*., 2006). "The leaves are rich in poly-unsaturated fatty acids (PUFA) such as linoleic, linolenic and oleic acid that regulate cholesterol levels in the body with the highest concentration of alpha-linolenic acid" (Ijarotimi *et al*., 2013) "and thus moringa leaves have fewer saturated fatty acids and more mono-unsaturated fatty acids. The contents of various unsaturated fatty acids differed in leaves and pods with leaves having higher concentration of poly-unsaturated fatty acids and lower concentration of monounsaturated fatty acids than the pods" (Aronson & Rayfield, 2002).

In addition to fat soluble vitamins like vitamin C and vitamin A (the precursor to beta-carotene), moringa contains water soluble vitamin B complexes like folate, pyridoxine and nicotinic acid (Wright *et al*., 2006). "Approximately 252% and 235% of daily vitamin A and ascorbic acid requirements, respectively can be met by leaves of drumstick. Green leaves contain significant levels of carotenoids, as well as tocopherols and vitamin C" (Prentki & Nolan, 2006). However, moringa also contains some anti-nutrients like phytates, tannins, saponins and oxalates (Kamalakkannan & Prince, 2006) "which may impede the consumption of several nutrients such as Zn, Fe, Ca, and Mg when consumed in high doses. The above-mentioned factors make eating leaves safer and more nutrient dense" (Aronson & Rayfield, 2002; Chumark *et al*., 2008).

Drumsticks are good sources of vitamins viz. A and C as well as essential minerals like calcium and magnesium. Moringa is rich in nutrition due to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. In fact, moringa can 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 (Rockwood *et al*., 2013). 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* (Mbikay, 2012). *M. oleifera* leaves contain about 25.5–31.0 mg of zinc/kg, which meet the daily dietary requirement of zinc (Lalas & Tsaknis, 2002). "Moringa leaves, pods and seeds contain many phytochemicals that make them one of the richest sources of nutrients" (Wani *et al*., 2024). "Due to the presence of naturally occurring compounds such as flavonoids, phenolic acids, carotenoids and glucosinolates, the leaves of moringa plant can serve as food supplements and health supplements" (Berkovich *et al*., 2013). Nutritional profile of various plant parts (per 100 g plant material) of moringa is given in the Table 2.

4. MEDICINAL AND HEALTH PROPERTIES

"Moringa (*Moringa oleifera*) is considered as a highly valuable medicinal plant due to its nutritional and pharmaceutical properties with all the plant parts having different bioactive chemical compounds such as phenolics, tannins, flavonoids, isothiocyanates, saponins, alkaloids, glucosinolates, vitamins and carotenoids" (Shinde & Kamble, 2020). "Furthermore, anticarcinogenic compounds viz. glucosinolates, iso-thiocyanates, glycosides and glycerol-1-9-octadecanoate are also present along with tannins, sterols, terpenoids, flavonoids, saponins, anthracenediones and anthraquinones" (Wright *et al*., 2006). Moringa leaves contain phyto-chemicals such as flavonoids, alkaloids, tannins, phenolic acids and saponins which have significant anti-cancerous properties (Kaneto *et al*., 1999). "Moringa seed oil contains approximately 76% PUFA, making it an ideal substitute for olive oil" (Lalas & Tsaknis, 2002). Moringa leaves are also rich in polyunsaturated fatty acids like omega-3 and omega-6 which benefit the body's vitality and several cardiovascular systems. Due to its high nutritional value, moringa can be used as an effective remedy for malnutrition as being used in countries like Senegal (Kasolo *et al*., 2010). Due to its phytosterol content, moringa is considered an excellent precursor of harmone lactogogues which increases milk production in lactating mothers. "It is used to treat malnutrition in children younger than 3 years old" (Mutiara-Titi & Estiasih, 2013; Sekhar et al., 2018). "Pregnant women need about six spoonsful of leaf powder a day to meet their iron and calcium needs. Therefore, keeping in view its nutritional and pharmacological properties, it can be used as a nutraceutical product. The main phytochemicals found in moringa leaves are astragalin, iso-quercetin and crypto-chlorogenic acid, which are well known for their antioxidant, antihypertensive, and anti-inflammatory properties" (Oduro *et al*.,

2008). “Its strong antioxidant properties are mostly due to its high phenol content” (Wani *et al*., 2024). “Due to these health advantages, a number of pharmaceutical formulations have been developed from this plant and are available in both the domestic and global markets” (Lalas & Tsaknis, 2002; Yang *et al*., 2006).

“A diet consisting of moringa leaves can help reduce obesity because of their low calorific value. Colon cancer can be prevented and treated with fiber-rich pods of moringa” (Oduro *et al*., 2008). “More than 300 diseases can be cured with *M. oleifera* which is a traditional herbal medicine used by Indians and Africans” (Gopalakrishnan *et al*., 2016) “and these properties are mainly due to phytochemicals contained in it. All parts of this plant are renewable sources of tocopherols (γ and α), phenolic compounds, ß-carotene, vitamin C and total proteins, including the essential sulphur amino acids, methionine and cysteine” (Ferriera *et al*., 2008; Abbas *et al*., 2018). “Several studies have shown that moringa can act as an anti-diabetic agent. Aqueous extracts of *M. oleifera* can cure streptozotocin-induced Type 1 diabetes and also insulin resistant Type 2 diabetes in rats”(Divi *et al*., 2012).

“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 which helps inhibit the growth of cancer cells” (Gopalakrishnan *et al*., 2016). “The compounds present in the leaves that are considered responsible for the anticancer activities are glucosinolates, niazimicin and benzyl isothiocyanate”(Hermawan *et al*., 2012).

“Moringa can help treatment of various other ailments. It is used to treat dementia as it has shown to promote spatial memory” (Sutalangka *et al*., 2013). “Moringa has been found to decrease acidity in gastric ulcers and hence can be used as an antiulcer agent” (Choudhary *et al*., 2013). “Studies have indicated that moringa can be a potent therapy for arthritis” (Mahajan & Mehta 2009).

5. CONCLUSION AND FUTURE PROSPECTS

Moringa has a rich nutritional profile containing much higher quantities of vitamin C, vitamin A, calcium, protein, potassium and iron than other common sources and offers a plethora of nutrition and health benefits. It is an effective remedy for malnutrition and blessed with many health benefits. More research on use of *M. oleifera* is needed in India so that the nutrients of this wonder tree are exploited for a variety of purposes. *M. oleifera* has great anti-diabetic and anti-cancer properties owing to the presence of many essential phytochemicals present in its leaves, pods and seeds. However, more studies are needed to corroborate the primary mechanisms of moringa as antidiabetic and anticancer agents. The tree as a native to India can become a great source of income for the nation if its potential as highly nutritional food is exploited by the industries and researchers by undertaking further research to corroborate earlier studies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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