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The role of *Moringa oleifera* pods, seeds, bark and root as functional food

Muthu Reka S* and SS Vijayanchali

Department of Home Science, The Gandhigram Rural Institute (Deemed to be University), Gandhigram, Dindigul Dist., Tamil Nadu, India.

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Abstract

Moringa oleifera also called as moringa, drumstick leaves, miracle tree. *Moringa oleifera* belongs to *Moringaceae* family. *Moringa oleifera* contains numerous health benefits. *Moringa oleifera* provides an abundant source of specific essential nutrients, biologically active components and phytochemicals like sterols, tannins, flavonoids, terpenoids, anthraquinones, saponins, alkaloids, isothiocyanates and glycoside compounds. *Moringa oleifera* is also good for the skin, hair, heart, liver, eyes, high blood pressure and it can help against anaemia, renal illness, obesity and diabetes. The main focus of this review is about the health benefits of *Moringa oleifera* seeds, bark, pod and root.

Keywords: *Moringa oleifera*; Drumstick Leaves; Pods; Seeds; Bark; Root; Antioxidant

1. Introduction

Plants are rich in secondary metabolites that can be used to treat and cure a wide range of illnesses and problems. These phytoconstituents are often obtained from various plant components such as the leaf, flower, bark, twig, stem, and tuber they act directly as medicinal agents (Cragg and Newman, 2001).

Moringa oleifera belongs to *Moringaceae* family, and is one of the most effective medicinal herbs. Native to India, Southern America, Africa, Europe, Sub-Himalayan regions, Asia, and the Middle East, it grows in tropical and subtropical climates (Alegbeleye, 2018), (Raman et al., 2018). The *Moringa oleifera* tree, which grows to a height of 10 to 12 m, is a small, quickly-growing evergreen tree (Athira et al., 2021).

Moringa oleifera is nutrient-dense due to the presence of various essential chemicals in its leaves, flower, pods, seeds and root (Rockwood et al., 2013). The leaves, fruits, flowers, and pods of the *Moringa oleifera* tree are utilized as incredibly nourishing greens. Various components of this plant possess a range of vital minerals and serve as a rich protein source, containing vitamins, β -carotene, amino acids, and a variety of phenolics (Aktar et al., 2019). All components of the *Moringa oleifera* plant contain important minerals such as calcium, phosphorus, manganese, zinc, and chromium. Additionally, the leaves and flowers of the plant may serve as valuable sources of iron supplements for both humans and animals (Ahmed et al., 2018).

Moringa oleifera is a well-known green that is abundant in essential minerals and phytochemicals (Gupta and Soin, 2020). Numerous bioactive phytochemicals such as flavonoids, carotenoids, saponin, vanillin, fatty acids, ascorbates, tocopherols, β -sitosterol, kaempferol, and quercetin can be found in *Moringa oleifera*'s flowers, roots, fruits, and seeds and have a wide spectrum of medical claims (Ma et al., 2020).

* Corresponding author: Muthu Reka S

Moringa oleifera is known to have hypoglycemic, antibacterial, antifungal, antioxidant, cholesterol-lowering, antihypertensive and anti-inflammatory properties (Oladeji et al., 2020). Due to its significant medicinal properties, it might be substituted for coriander leaves to increase flavour (Gandji et al., 2018).

Moringa oleifera has also been used to modify the immune system in pathological situations including anaemia, anxiety, asthma, blood impurities and cholera. It has also been used to treat malnutrition, edema, hyperglycemia, cancer, bacterial and viral infections (Saini et al., n.d.). *Moringa oleifera* is also good for the skin, hair, eyes, liver (Meireles et al., 2020).

1.1. *Moringa oleifera* Pods

Moringa oleifera pods are brown, pendulous, triangular in shape and divided into three sections according to length. 30-120cm long and 1.8cm broad when completely dried. Fruit production takes place mostly in March and April. Each fruit has 26 seeds at the beginning of its growth. Pods are green while juvenile and become brown when they are grown (Islam et al., 2021).

Moringa oleifera pods are incredibly nutrient-dense and include phytochemicals, vitamins, minerals, and amino acids. A good dose of protein, ash, non-structural carbohydrates, lipids, and fiber is found in *Moringa oleifera* pods. Fatty acids such as oleic, linoleic, palmitic, and linolenic acids are also present. Vitamins C and A are very abundant in the pods. The complex chemical components found in *Moringa oleifera* pods include antibacterial and anti-inflammatory capabilities, which help strengthen the immune system's innate defense (Prentki and Nolan, 2006).

Moringa oleifera young pods have 19.34% protein, 1.28% fats, 46.78% fibre, 30% amino acids and 24.98% carbs (Sánchez-Machado et al., 2010). According to one research, one cup of fresh, sliced pods (100 g) contains 157% of an adult's daily need of ascorbic acid. It is also used to extend the food's shelf life and easy to store it. Because pods contain anti-helminthic effects, they are used to treat spleen infections and liver infections. It is also used to alleviate articular discomfort (Masih et al., 2019).

Recent research conducted demonstrated that consuming one bowl of sliced fresh pods, which weighs 100 g, provides 157% of the recommended daily intake of vitamin C for adults. Moreover, it is utilized to prolong the durability of food and for its preservation. These pods possess anti-helminthic properties and are employed in the treatment of liver and spleen infections. Additionally, they are utilized to alleviate articular pains, commonly known as joint pains (Masih et al., 2019).

The pods of *Moringa oleifera* also guard against bacterial activity, cancer, oxidative stress, antidiabetic, inflammation, hepatic fibrosis, liver damage, hypercholesterolemia, and other harmful conditions (SWATIq et al., 2018), (Shah et al., 2022).

1.2. *Moringa oleifera* Seeds

Moringa oleifera seed was harmless and suggested using it as a coagulant in developing nations (Okereke and Akaninwor, 2013). *Moringa oleifera* seeds are spherical shape semi-permeable seed shell. Three wings on the hull itself are spaced 120 degrees apart from top to bottom. Each tree may yield 15,000 to 25,000 seeds annually (Shah et al., 2022).

Seeds feature a mid-brown seed core with three light wings. The seed core can be dark brown or black in colour, although it can also be milky. *Moringa oleifera* has a variety of bioactive categories, including alkaloidal steroidal, phenolic compounds, flavonoids, terpenes, zeatin, quercetin and different carbohydrates such as L-arabinose, L-galactose, mannose, and xylose, among other phytonutrients (Stadtlander and Becker, 2017).

The high levels of protein, minerals and unsaturated fatty acids, primarily oleic acid is an excellent source in *Moringa oleifera* seeds make them valuable raw materials for culinary applications (Milla et al., 2021), (Özcan, 2020). According to recent studies, *Moringa oleifera* seed powder increases the nutritional content of a variety of foods, including bread, cookies, cakes, snacks, and cereal gruels (Rabie et al., 2020).

Seeds of *Moringa oleifera* are known to contain a substantial amount of cystine and methionine, comparable to that found in eggs and milk. The proteins present in *Moringa oleifera* seeds are easily digested due to their urease activity and lack of trypsin inhibitors. In addition, the powdered form of these seeds is commonly utilized as a natural flocculent to clarify turbid water (Aslam and Asghar, 2021).

Moringa oleifera harbors over 30 inherent antioxidants within its seeds, which encompass the likes of kaempferol. In addition to its antioxidant properties, kaempferol also enhances cellular functionality and metabolism (Vargas-Sánchez et al., 2019).

The seeds of the *Moringa oleifera* seed are a good source of antioxidant activity, lipids, proteins, and minerals like calcium, magnesium, zinc (Liang et al., 2019). *Moringa oleifera* seeds' nutritional analysis revealed that they included a range of protein concentrations (9.98–51.80 g/100 g), ash concentrations (3.60–5.0 g/100 g), fibre concentrations (17.26–20.0 g/100 g), and carbohydrate concentrations (3.6–18.0 g/100 g) (Busani et al., 2011).

Moringa oleifera seeds consist of 28.77% carbs, 28.02% crude protein, 33.78% crude fat, 94.74 mg/100 g vitamin C, 2.84 mg/100 g calcium, and 129.03 mg/100 g sodium (Igwilu et al., 2017). The amount of cystine and methionine in *Moringa oleifera* seeds is comparable to that of eggs and milk. *Moringa oleifera* seed protein is highly digestible (93%) due to urease activity and the absence of trypsin inhibitors. As a natural flocculent, *Moringa oleifera* seed powder is used to clear murky water (Masih et al., 2019). *Moringa oleifera* seed extract lowers lipid peroxides in the liver and contains antihypertensive substances (Ali et al., 2022).

A clinical trial is being conducted to assess the effectiveness of *Moringa oleifera* seed kernels in the treatment of bronchial asthma. For three weeks, 20 patients with mild to severe asthma were given 3 kg of dried seed kernels. The results demonstrated that *Moringa oleifera* extracts significantly reduced the intensity of asthma symptoms while simultaneously improving lung function metrics (Agrawal and Mehta, 2008).

Patients with bronchial asthma can benefit from using *Moringa oleifera* seeds as a treatment. 3g daily for three weeks is the recommended dose. It produced positive effects such a decrease in the erythrocyte sedimentation rate, an increase in the heartbeat value symptoms score, and a decrease in the intensity of asthma episodes. Enforced expiratory volume, vital capacity, and expiratory flow rate values all improved after 3 weeks of therapy. *Moringa oleifera* seed alcohol extract has spasmolytic effects on histamine- and acetylcholine-induced bronchospasm (Paikra and Gidwani, 2017).

Polyunsaturated fatty acids abound in *Moringa oleifera* seeds. Aside from that, the existence of phytochemical substances is responsible for medicinal plants' therapeutic effectiveness (Mahfuz and Piao, 2019). Due to the presence of benzyl isothiocyanate and moringine the seeds of this plant have antibacterial potential (Kamran et al., 2020).

In addition to being used to season food, *Moringa oleifera* seeds can also be used to purify water. In some regions, they are also consumed as roasted nuts (James and Zikankuba, 2017). The seeds of the *Moringa oleifera* are used as a purgative and to treat hysteria, tumors and scurvy (Posmontier, 2011). In addition to acting as antibacterial and anti-inflammatory agents, seeds of *Moringa oleifera* are used in the treatment of hyperthyroidism, antiheroes-simplex virus arthritis, rheumatism, epilepsy, cardiac-stimulating properties and sexually transmitted infections (Ram and Rastogi, 2004).

1.3. *Moringa oleifera* Bark

Bark extract in aqueous form lowers the weight of stones formed using 1% ethylene glycol. *Moringa oleifera* bark has curative and preventative potential (Sekhar et al., 2018). The bark is used to treat upper respiratory tract infections and as an aphrodisiac (Posmontier, 2011).

It was demonstrated in a clinical trial involving 30 patients that 40 mL of a *Moringa oleifera* stem bark decoction taken twice daily was beneficial in treating the signs and symptoms of a urinary tract infection (Maurya and Singh, 2014). With the use of several *Moringa oleifera* bark extracts, anticholesteremic and antilipidemic efficacy in rats was also confirmed. The gum derived from the bark of the *Moringa oleifera* tree is employed in the culinary realm for the purpose of adding flavour to various dishes (Mulugeta and Fekadu, 2014).

The bark of the *Moringa oleifera* plant is used to treat eye problems and stop the growth of tuberculous glands in the neck and spleen, eliminate tumors, and treat ulcers. The root bark juice is applied to the ears to relieve earaches and is also used as a pain reliever in dental cavities (Anwar et al., 2007), (Qi et al., 2019).

1.4. *Moringa oleifera* Root

Roots of the *Moringa oleifera* plant exhibit elevated quantities of antinutrients in comparison to other plant components, thereby restricting its suitability for consumption. Roots are characterized by increased levels of tannins and oxalates, which do not serve as beneficial sources of nutrition. Furthermore, they contain elevated amounts of carbohydrates, sodium, arginine, lysine, and vitamin-C (Vargas-Sánchez et al., 2019).

As a spice *Moringa oleifera* root is eaten. The antibacterial, anticancer, antifungal, antiulcer, and anti-inflammatory actions of roots are also present (Shank et al., 2013; Steve and Babatunde, 2013), (Abubakar and Usman, 2016), (Abd-Rabou et al., 2017).

The effects of *Moringa oleifera* root extract on foot edema formation in rats were equivalent to those of the analgesic and antipyretic nonsteroidal anti-inflammatory drug phenylbutazone (Sandeep et al., 2019), (Aderinola et al., 2020).

Indians utilize the roots of the *Moringa oleifera* plant to cure ailments including edema, wounds, ulcers, hiccups, asthma, rheumatoid arthritis, dyspepsia, gout, eye problem, renal stones, and illnesses of the liver and spleen (Leone et al., 2015).

The juice derived from the root bark of the *Moringa oleifera* plant is applied to the ears to alleviate earaches. Additionally, it is used as a painkiller by filling a tooth cavity. Moreover, it possesses properties that can combat tuberculosis (Hossain et al., 2022).

2. Conclusion

From the review, it is summarized that the *Moringa oleifera* has numerous health benefits. *Moringa oleifera* has a high amount of antioxidants, phytochemicals, and bioactive components. *Moringa oleifera* is an abundant source of carbohydrate, protein, fat, vitamins like A and C, and minerals like calcium, sodium and potassium. *Moringa oleifera* is also good for the skin, hair, liver, eyes, blood pressure, and curing anaemia, renal illness and diabetes mellitus.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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