Potentiality of *Moringa oleifera* for food and nutritional security - A review

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**ABSTRACT**

*Moringa oleifera* tree is referred to as a miracle tree due to its rich source of certain macro and micro nutrients of great importance in human nutrition. There is considerable variation among nutritional values of *moringa*, which depends on factors like genetic background, environment and cultivation methods. The plant is proven with tremendous medicinal properties. *moringa* has been described as one of the most amazing trees God has created. Almost every part of the *moringa* tree, viz. fruit, flower, seed, bark, root and gum is a rich repository of proteins, vitamins and minerals including potassium, calcium, phosphorous, iron, folic acid as well as β-carotene. The review covers health benefits of *moringa* as well as technology of post-harvest handling and processing of *moringa* for utilization in value added products.

**Key words:** Human nutrition, Medicinal importance, *Moringa oleifera*, Post-harvest handling, Value addition.

*Moringa oleifera*, Lam (Syn M. Pterygosperma Gaertn), is a natural as well as cultivated variety of the genus *Moringa* belonging to family Moringaceae. *Moringa Oleifera* commonly called Drumstick, Horseradish or Miracle tree. The tree is a fast-growing, drought-resistant tree that is native to the southern foothills of the Himalayas in north-western India. The tree is grown mainly in semi-arid, tropical, and subtropical areas (Majhi, 2013). India is the largest producer of *moringa*, with an annual production of 20.61 lakh metric tonnes of tender fruits from an area of 61600 hectare. Among Indian states, Andhra Pradesh leads both in area and production followed by Karnataka, Tamil Nadu (Pandey, 2013).

The plant is grown for food and it is an exceptionally nutritious vegetable tree with varieties of potential value (Ozumba, 2011). The tree is valued mainly for its tender pods, which are esteemed as vegetable, tender leaves and flowers are also used as vegetable. There is considerable variation among nutritional values of *moringa*, which depends on factors like genetic background, environment and cultivation methods (Brisibe et al., 2009). Nutritional composition of the plant plays a significant role in nutritional, medicinal and therapeutic values (Al-kharusi et al., 2009). Green leaves and fruit pods of drumstick are rich sources of minerals like calcium, iron and good sources of vitamin A, B, C and protein including fair amounts of sulphur containing amino acids (Ram, 1994). Apart from providing nutrition, it also contributes to the appealing colour, texture and flavour of the food.

**MEDICINAL IMPORTANCE OF MORINGA OLEIFERA**

*Moringa oleifera* is an important food commodity which has had enormous attention as the ‘Natural Nutrition of the Tropics’. The leaves, fruit, flowers and immature pods of this tree are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa (D’souza and Kulkarni, 1993; Anwar and Bhangar, 2003; Anwar et al., 2005, 2007). It is known as ‘Mother’s Best Friend’ because of its utilization to increase woman’s milk production and is sometimes prescribed for anaemia (Estrella et al., 2000; Dawn et al., 2015). A number of medicinal properties have been ascribed to various parts of this highly esteemed tree. Some common medicinal uses of *Moringa Oleifera* are presented in Table 1.

**POST-HARVEST HANDLING AND PROCESSING OF MORINGA OLEIFERA**

*Moringa* has been described as one of the most amazing trees God has created. Almost every part of the *moringa* tree, viz. fruit, flower, seed, bark, root and gum is a rich repository of proteins, vitamins and minerals including potassium, calcium, phosphorous, iron, folic acid as well as β-carotene. The need for preservation of *Moringa oleifera* is very essential due to its medicinal and therapeutic properties. Also the consumers now-a-days look for the ready to eat form of food items. Thus it becomes necessary to preserve the drumstick. Fresh vegetables may be dried, frozen, fermented, pasteurized or canned. Drumstick can be utilized as flavoring and thickening agent in various dishes. It gives distinct palatable taste and is a rich source of glutamic acid.

**Food products from *moringa***: Various *moringa* based common healthcare products are available viz. *Moringa Zinga, Moringa Pharm, Moringa Seeds, Moringa Tea, Moringa Capsules, Moringa Fruit powder, Moringa Dried...”

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Leaves, Miracle Malunggay, Pongamonga Moringa, Zijasart Drink and canned Moringa (Pandey, 2013). Almost all parts of this plant have been used for various aliments in the indigenous medicine of south Asia (Anjorin et al., 2010; Khalafalla et al., 2010; Pandey et al., 2012). Moringa can be utilised in various value added food products to improve its nutritional and medicinal values.

Technologies for value addition to Moringa oleifera and its utilization: The name of the drumstick derives from the shape of the pod, resembling the slender and curved stick used for beating drum. The nutritional value per 100 g of edible portion of Moringa pod is carbohydrate: 8.53%, protein: 2.10%, total fat: 0.20%, cholesterol: 0%, dietary fibre: 3.2%, calcium: 30mg, phosphorous: 110mg, iron: 5.3mg and vitamin C: 120mg (Fahey, 2005). Moringa pods can be often cooked and eaten like green beans or can preserve by many ways. Freshly harvested drumstick samples were peeled, cut, rinsed and canned in 2.5% brine at 55% solids content. Processing at 121°C for 20 minutes resulted in optimum product safety and quality with 69% retention of vitamin C and totally killed pathogens (Wijayawardana and Bamunuarachchi, 2002; Nithya Priya et al., 2013).

Drumstick fruit can be dried after treating with salt and turmeric solution followed by drying using freeze drying, oven drying, microwave vacuum, spray drying, wind drying and sun drying techniques to extend the shelf life of Moringa oleifera without alteration in its nutritional value (Compaore et al., 2011; Gyamfi et al., 2011). Drying of Moringa pods and leaves can be carried by the process involves various unit operations like washing, steeping in anti-oxidant solution, blanching at 90-95°C for 3-4 minutes, cooling, sulphitation, drying in cabinet dryer at a temperature range of 60 to 70°C for a period of 7 to 9 hrs of the above treated drumstick segments moisture content of 5 - 8 %, followed by milling (Ramteke et al., 2013).

Moringa leaves possess high protein value as well as low fibre content which has made it suitable for the extraction of leaf protein for use as low cost source of protein (Awasthi and Tondon, 1988). Leaves are rich source of major and trace elements viz. calcium, phosphorous and zinc vary from 0.9 to 2.9 %, 0.4 to 1.2 % and 17.5 to 46.2 mg/ kg, respectively (Gopalan et al., 2004). The young leaves are edible and are commonly cooked and eaten like spinach or used to make soups and salads or stored as dry powder for many months without refrigeration, without loss of nutritional value. Nambiar (2008), reported that incorporation of blanched Moringa leaves into traditional recipes (Mung and Chana) increased the level of micronutrients (3955 µg carotene, 46 mg ascorbic acid and 1.6 mg Iron). One serving of each of these recipes (30 g raw weight of pulses) could incorporate a maximum of 20 g of fresh drumstick leaves. Mishra et al. (2012) standardised processing technology of Moringa oleifera leaves for human consumption. It is estimated that only 20-40% of vitamin A will be retained, if leaves are dried under direct sunlight, but that 50-70% will be retained if leaves are dried in the shade. Loading density was 1kg/m2 with four days drying. Dried leaves can be grinded using pulversiser (0.5-1.0 mm pores size) and further the powder is dried at 50°C for 30 minutes; followed by cooling, storage in air tight container below 24°C, had a shelf life of 6 months.

Dried Moringa powder can be consumed in raw form or can be added to various value added food products for nutrient fortification viz. biscuit (1%), butter milk (3%), weaning food (10%), soup (10%), labneh cheese (2%) (Lemmens, 2014; Otoluwa et al., 2014; Ukey et al., 2014). The daily dose of 10 g of powdered Moringa dry leaves was decided upon, as it was the quantity recommended (Zongo et al., 2013). Iskandar et al. (2015) assessed the effect of Moringa oleifera leaf extracts supplementation in preventing maternal anemia and low-birth-weight and reported significant increase of hemoglobin level.

Technology for blended beverage consisting of 50-52% Moringa, 38-40% Pineapple and 10-12% carrots was standardised. Beverage contained 2.9 g protein, 1.02 mg iron and 159.14 mg vitamin C, per 100ml and had shelf life of 8 weeks at ambient conditions. Moringa juice was extracted from leaves and the blended with pineapple and carrot juice and pasteurised at 62°C for 30min (yarely et al., 2013). Fresh Moringa oleifera beverage is an excellent means of distributing nutrients to the malnourished and other consumers. Moringa leaf extract can be used as natural antioxidant to preserve raw beef packaged in high oxygen modified atmospheric packaging (Manzoor et al., 2015).

Moringa exhibits potential to process into herb tea. Moringa leaf is rich in minerals, amino acids, vitamins and β-carotene. It also contains a rare combination of health-promoting antioxidants: zeatin, quercetin, sitosterol, caffeoylquinic acid and kaempferol. Herb tea brewed from

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product 50% dried Moringa leaf, 30% Roselle, 20% Lemon grass was the most acceptable (Anwar et al., 2007; Tetteh, 2009).

The Moringa seeds yield 38–40% edible oil that is commercially known as “Ben oil”. The refined oil is clear, odorless, and resists rancidity. The seeds of Moringa oleifera is good source of different tocopherols (α, β, δ), the concentration of those reported to be 98.82-134.42, 27.90-93.70 and 48.00 – 71.16mg/kg, respectively (Tsaknis et al., 1999; Anwar and Bhangar, 2003; Mehta et al., 2011). The performance of the high-oleic Moringa oleifera seed oil in deep frying was evaluated by comparing its frying stability with other conventional frying oils. The oils were used as a frying media to fry potato chips for 6 h a day up to a maximum of 5 days. Total peroxide content was significantly lower in Moringa seed oil compared to soybean and palm oils (Abdulkarim et al., 2007).

Aremu and Akintola, (2014) reported that dried Moringa seeds powder could be a good source of antioxidants and antibacterials for food and pharmaceutical industries. Compaoire et al. (2011) reported utilization of natural antioxidants of Moringa seeds for food fortification.

Drumstick flower can be cooked and oven dried and steeped as tea. In some parts of India, flowers are used for preparation of pickles. Gopalan et al. (2004) reported that the drumstick flower contains traces of alkaloids and its ash is rich in potassium and calcium. Flowers contains nine amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin, and kaempferat, the ash is rich in potassium and calcium (Ruckmani et al., 1998). Moringa gum is an exudates from the stem of drumstick. It has been successfully used as tablet binder, emulsifier and gelling agent, suspending agent, stabilizer and thickener (Faizi et al., 1994a; Thillaiavan and Samraj, 2014). Purified, whole – gum exudate from Moringa oleifera has been found to contain L-arabinose, L-galactose, L-glucuronic acid, and L-rhamnose, L-mannose and L-xylene, while a homogeneous degraded gum polysaccharide consisting of L-galactose, L-glucuroni acid and L-mannose has been obtained on mild hydrolysis of whole gum with acid (Bhattacharya et al., 1982). Moringa root starch gaining popularity as a potential food, pharmaceutical and Industrial Biomaterial (Aremu and Akintola, 2014)

Non-food uses of Moringa oleifera: Application of low cost Moringa oleifera seeds is recommended for eco-friendly, nontoxic, simplified water treatment where rural and peri-urban people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water. Moringa oleifera seeds as natural absorbent and environmentally friendly antimicrobial agent for purification of ground water for drinking purpose (Folkard, 1999; Okuda et al., 2001, Bichi, 2013). Moringa oil has potentiality as biodiesel, due to its high content of oleic acid (>70%) with saturated fatty acids comprising most of the remaining fatty acid profile. As a result, the methyl esters (biodiesel) obtained from this oil exhibit a high cetane number of approximately 67, one of the highest found for a biodiesel fuel (Rashid et al., 2006). The seed oil is used in arts and for lubricating watches and other delicate machinery, and useful in the manufacture of perfumes, soap manufacturing and hairdressings. The pressed cake obtained after oil extraction may be used as a fertilizer. Moringa makes a great fodder for cattle. The weight of livestock increased upto 32 per cent through Moringa feed and their milk yield of cows increased by 43%. Moringa leaves are utilised for Biogas (methane) production. Experiments have established that it is possible to produce 4400 cubic meters of bio gas per hectare per year. The industrial uses of the drumstick tree include the use of its wood in paper and textile industries and bark in the tanning industry (Mehta et al., 2011; Naumani et al., 2013). It also has cosmetic applications like remedy for ear ache and ointments for skin conditions. The oil rubbed on the skin is said to prevent mosquitoes from biting. The seed cake remaining after oil extraction may be used as a fertilizer or as a flocculent to purify water (Premi and Sharma, 2013).

CONCLUSION
Moringa truly appears to be a “Miracle” plant having countless benefits for humanity and thus should be taken as a high quality gift of nature at very low price. The Moringa oleifera plant is credible alternative to not only providing good nutrition, but also to cure and prevention of diseases. Moringa should be promoted for greater consumption to improve nutrition. We need to design and develop strategy on war footing in order to explore and utilize the full benefits of Miracle Moringa tree. Considering the potentiality and enormous benefits to humanity, the time has come for exploring its avenue for food uses and to standardize and commercialise technologies for developing value added and highly nutritious products from Moringa.

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