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Unlock your health potential with moringa leaves (*Moringa oleifera*)

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Abstract
Moringa oleifera, native to India, grows in the tropical and subtropical regions of the world. It is commonly known as 'drumstick tree' or 'horseradish tree'. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. With its high nutritive values, leaves are suitable for either nutritional or commercial purposes. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used in treatment of malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent, cardio protective, antihypertensive and cholesterol lowering activities.

Keywords: antioxidant, anticancer, anti-inflammatory, cardio protective

1. Introduction
Moringa oleifera commonly known as Drumstick leaves belonging to the family of *Moring aceae*is an effective remedy for malnutrition. Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves. In fact, Moringa is said to 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 [1].Moringa is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones. These compounds increase the estrogen production, which in turn stimulates the proliferation of the mammary gland ducts to produce milk. It is used to treat malnutrition in children younger than 3 year [3]. About 6 spoon fuls of leaf powder can meet a woman's daily iron and calcium requirements during pregnancy. This review provides an overview on the cultivation, nutritional values, medicinal properties for commercial use and pharmacological properties of Moringa.

Fig 1: *Moringa Oleifera Leaves*

2. Nutritive properties
Every part of *Moringa oleifera* is a storehouse of important nutrients and antinutrients. The leaves of *Moringa oleifera* are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper [2]. 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* [4]. Phytochemicals suchas tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugar present along with anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate [5]. Moringa leaves also have a low calorific value and can be used in the diet of the obese. The pods are fibrous and are valuable to treat digestive problems, throat and colon cancer [6]. A research shows that immature pods contain around 46.78% fiber and around 20.66% protein content. Pods have 30% of amino acid content, the leaves have 44% and flowers have 31%. The immature pods and flowers showed similar amounts of palmitic, linolenic, linoleic and oleic acids [7].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. While 8 ounces of milk can provide 300-400 mg, Moringa leaves can provide 1000 mg and Moringa powder can provide more than 4000 mg. Moringa powder can be used as a substitute for iron tablets, hence as a treatment for anemia. Beef has only 2 mg of iron while Moringa leaf powder has 28 mg of iron. It has been reported that Moringa contains more iron than spinach [7].Good dietary intake of zinc is essential for proper growth of sperm cells and is also necessary for the synthesis of DNA and RNA. *Moringa oleifera* leaves show around 25.5–31.03 mg of zinc/kg, which is the daily requirement of zinc in the diet [9].

A complete list of nutrients available in leaves, are shown in Table

Table 1: The nutrient composition of fresh leaves, dry leaves and leaf powder.

Nutrients	Fresh leaves	Dry leaves	Leaf powder
Calories (cal)	92	329	205
Protein (g)	6.7	29.4	27.1
Fat (g)	1.7	5.2	2.3
Carbohydrate (g)	12.5	41.2	38.2
Fibre (g)	0.9	12.5	19.2
Vitamin B1 (mg)	0.06	2.02	2.64
Vitamin B2 (mg)	0.05	21.3	20.5
Vitamin B3 (mg)	0.8	7.6	8.2
Vitamin C (mg)	220	15.8	17.3
Vitamin E (mg)	448	10.8	113
Calcium (mg)	440	2185	2003
Magnesium (mg)	42	448	368
Phosphorus (mg)	70	252	204
Potassium (mg)	259	1236	1324
Copper (mg)	0.07	0.49	0.57
Iron (mg)	0.85	25.6	28.2
Sulphur (mg)	–	–	870

All values are in 100 g per plant material [8].

3. Antinociceptive Activity

The antimigraine potential of leaf juice alcoholic fraction of Moringa olifera, which is traditionally used in the treatment of migraine was studied. The study showed that Moringa may be effectively used in the treatment and management of migraine [11]. The fresh leaf juice and ethanolic extract of the leaves of *Moringa oleifera* were administered orally at varying doses in mice and were tested for antinociceptive activities using three models, writhing induced by Acetic acid, formalin induced paw licking and tail flick test using analgesiometer. Study showed a significant antinociceptive activity of Moringa olifera [12].

4. Cardio Protective, Antihypertensive and Cholesterol Lowering Activities

A study performing comparison of Moring aolifera leaf extract with antenolol (a selective ß1 receptor antagonist drug, used for cardiovascular diseases) reported Moring aolifera leaf extract as hypolipidimic, lowering body weight, heart weight, serum triglyceride level and serum cholesterol level in experimental animals [13]. Keeping simvastatin as control, antiatherosclerotic and hypolipidaemic effect of Moringa leaves were also shown in another study [10]. Moringa also produces cardioprotective role in isoproterenol (ISP) induced myocardial infarction. It was reported that Moringa leaves treatment plays cardio protective effects in male wistar albino rats on biochemical enzymatic parameters including, superoxide dismutase, catalase, glutathione peroxidase, lactate dehydrogenase, and creatine kinase MB. Several bio active compounds contained in Moringa leaves exert direct effect on blood pressure and thus may be used for the stabilization of blood pressure. Moringa leaves compounds leading to blood pressure lowering effect includes nitrile, mustard oil glycosides and thiocarbamate glycosides present in Moringa leaves [14]. Moringa leaves contain -sitosterol, a bioactive phyto constituent, having cholesterol reducing effect. This compound has been shown to decrease cholesterol level in high fat diet fed rats [18].

5. Protection in Eye Diseases

Vitamin A deficiency is a major cause of blindness. Consumption of Moringa leaves, and pods and leaf powder, rich source of vitamin A, can prevent night blindness and eye problems in children. Consumption of drumstick leaves with oils can improve vitamin A nutrition and can delay the development of cataract [15]. Moringa leaves as a supplementary food was highly accepted for integrated child development scheme supplementary food (ICDS-SFP) because it is enriched in vitamin A [26]. A Study showed retino protective effects of Moringa leaves via antioxidant, anti-inflammatory, and anti-angiogenic mechanisms in streptozotocin-induced diabetic rats. Moringa oliferay be useful in preventing diabetes induced retinal dysfunction [25].

6. Antidiabetic Activity

Moringaolifera potential as a therapeutic agent for diabetes has been explored. In type 2 diabetic rats, Moringa leaves significantly reduce blood glucose concentration. Leaves are potent source of polyphenols, responsible for hypoglycemic activity [16]. The extract from Moringa leaf decreases sugar levels in the blood within 3 h after intake [17].

7. Wound Healing Properties

Leaf extract was tested for analyzing wound healing capacity. Three wound models viz excision wound, incision wound and dead space were chosen. Ethyl acetate extracts (10% extract in the form of ointment) showed significant activity that is comparable with the standard vicco turmeric cream. Phytosterols and phenolic compounds present in these extracts promote the wound healing activity [19].

8. Anticancer properties

Cancer is a common disease and one in seven deaths is attributed due to improper medication. Around 2.4 million cases are prevalent in India, while there are no specific reasons for cancer to develop. Several factors like smoking, lack of exercise and radiation exposure can lead to the disease [27]. Cancer treatments like surgery, chemotherapy and radiation are expensive and have side effects. *Moringa 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, thereby inhibiting the growth of cancer cells. Soluble

and solvent extracts of leaves have been proven effective as anticancer agents. Furthermore, research papers suggest that the anti-proliferative effect of cancer may be due to its ability to induce reactive oxygen species in the cancer cells. Research shows that the reactive oxygen species induced in the cells leads to apoptosis. This is further proved by the up regulation of caspase 3 and caspase 9, which are part of the apoptotic pathway (Ethnopharmacol 2008). Anticancer agents targeting cancer using ROS (Review of Symptoms) induction are common, but these substances should also be able to attack the antioxidant enzymes [21]. However, Moringa leaf extracts have been shown to be antioxidants and anticancer agents which induce ROS. The exact behavior of the two contrary attributes of the leaves is yet to be explored. The compounds of the leaves that are held responsible for the anticancer activities are glucosinolates, niazimicin and benzyl isothiocyanate [28].

9. Other uses

Moringa oleifera is used to treat dementia, as it has been shown to be a promoter of spatial memory. The leaf extracts have shown to decrease the acetylcholinesterase activity, thereby improving cholinergic function and memory [22, 23] showed that moringa in diet of rats, can increase protein content and decrease levels of urea and creatinine in blood, preventing renal dysfunction. Moringa decreased cidity in gastric ulcers by a percentage of 86.15% and 85.13% at doses of 500 mg and 350 mg, respectively and therefore can be used as an antiulcer agent [23]. Moringa is prescribed by herbal practitioners for patients with AIDS. The hydro-alcoholic extract of moringa flowers reduced the levels of rheumatoid factor, TNF-alpha and IL-1 in arthritic rats. This proves that moringa can be a potent therapy for arthritis [42]. Microbial diseases are widespread and there is a need for antimicrobial agents, *Moringa oleifera* has been proven as a good antimicrobial agent [24]. Study by [29] has shown that the extracts of *Moringa oleifera* can act against bacteria like *Bacillus subtilis*, *Staphylococcus aureus* and *Vibrio cholera*.

10. Conclusion

Moringa leaves have anti-nociceptive activity, cardio protective, antihypertensive cholesterol lowering activities, protection in eye diseases and antidiabetic activity. Moringa may be effectively used in the treatment and management of migraine. Leaves have a potential therapeutic agent for diabetes has been explored. Consumption of these leaves, pods and leaf powder are rich source of vitamin A, can prevent night blindness and eye problems in children. Several bio active compounds contained in Moringa leaves exert direct effect on blood pressureand thus may be used for the stabilization of blood pressure. In conclusion Moringa leaves consumption can be encouraged on daily basis and recommended for all age groups for several health benefits.

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