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Krishna Bihari Sharma
Department of Agriculture Economics, Swami Vivekanand University, Sagar, Madhya Pradesh, India

Mohit Kumar
Department of Agriculture, Chandigarh Group of Colleges, Jhanjeri, Mohali, Punjab, India

Satendra Kumar Sharma
Department of Agriculture, Chandigarh Group of Colleges, Jhanjeri, Mohali, Punjab, India

Corresponding Author:
Krishna Bihari Sharma
Department of Agriculture Economics, Swami Vivekanand University, Sagar, Madhya Pradesh, India

A review article on immunostimulatory potential in *Moringa oleifera*

Krishna Bihari Sharma, Mohit Kumar and Satendra Kumar Sharma

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Abstract
The present review study was conducted during the year 2020 at Chandigarh Group of Colleges, Jhanjeri, Mohali. The study results indicated that Moriga is one of the nutritious source among all the food sources. The different phyto-chemicals play a vital role to improve the human immune system. The different chemical constituents present in different parts of the plant having nutraceutical property and can be utilized in different ways. Moringa may be a great alternate source of Vitamins, Protein, Fiber, Carbohydrates and different Minerals. Some of the severe diseases like Cancer, Diabetics, Cerebral ischemia etc. can be completely avoid by consuming *Moringa oleifera*.

Keywords: Moringa, cancer, nutrients, phyto-chemicals

Introduction
Moringa, (*Moringa oleifera*), also known as horse radish tree or drumstick tree, little deciduous tree (family Moringaceae) local to tropical Asia yet in addition naturalized in Africa and tropical America. Blossoms, cases, leaves, and even twigs are cooked and eaten. Moringa trees can arrive at a stature of around 9 meters (30 feet) and have corky dark bark. The leaves are bi-or tripinnately compound and have oval-formed leaflets with conspicuous swellings (pulvini) at the join section. The angled dagger like fruits sometimes grow upto 18 inches (45 cm) long and are explosively dehiscent. Its various parts are rich in proteins, nutrients and minerals and present distinctive pharmacological and biochemical potential. Moreover, *M. oleifera* seeds are well used in the treatment of water and emanation, due to their coagulation, flocculation and sedimentation properties, their potency to improve water quality, by decreasing organic matter and microbial load, with special applicability in intensive animal production systems, for example aquaculture. Furthermore, due to its high healthy benefit and some restorative properties, this tree can be a nutritional and medical alternative for socially ignored populations. In this context, this review deals with *M. oleifera*, emphasizing its chemical compounds, dietary, pharmacological and antimicrobial properties, applications in the treatment of water effluents and natural and social aspects.

Chemical Constituents
The chemical constituents of *M. oleifera* stems, leaves, flowers, Pods and seeds are analyzed for the purpose of bioactive compounds, demonstrating the predominance of secondary metabolites, like phenolic acids, acid, ellagic acid, chlorogenic acid, ferulic acid, glucosinolates, flavonoids, quercetin, vanillin and kaempferol, which have nutritional, pharmaceutical and/or antimicrobial properties. However, the amount of these metabolites in *M. oleifera* extracts varies consistent with geographic location, soil, sun exposure and climate. Moreover, the tactic and solvents used for extraction can modify the content of the compounds obtained from the plants, Department of Agriculture, Chandigarh Group of Colleges, Jhanjeri, Mohali, Punjab, India phenols and flavonoids. Many phytoconstituents of *M. oleifera* have been isolated and studied, as shown in Table.1 The main phytochemicals obtained from the plant include: tannins, saponins, alkaloids, flavonoids, phenols and glycosides from leaves; tannins, steroids, flavonoids, alkaloids, glycosides, quercetin and terpenoids from flowers; ferulic acid, catechins, epicatechin, protocatecuic acid, vanillin, caffeic acid, cinnamic acid, phytosterol, quercetin, gallic acid, glycosides and phenols from seeds; 3-dibenzylurea,

quercetin, glycoside, procyanidins, rhamnoglucoside quercetin, aurantiamide acetate, and chlorogenic acid from roots; and alkaloids, procyanidin, sterols, triterpenoids, glycosides, tannins b-sitosterol and octacosanoic acid from stem bark (Jimenez *et al.* 2017) [2].

Table 1: Different chemical constituents in plant parts.

Plant part	Phyto-constituents	Group
Seeds	b-sitosterol	Phytosterol
Leaves, stem	4-a-L-rhamnopyranosyloxy-	Glucosinolate
Leaves, seeds	4-(a-L-rhamnosyloxy-benzyl)	Glucosinolate
Leaves	4-O-glucopyranosyl-caffeoyl quinic acid	Caffeoylquinic
Seeds	Glycerol-1-(9-octadecanote)	Glycoside
Seeds, leaves, Stem and roots	Kaempferol	Flavonoid
Leaves and Seeds	Niazimicin	Glycoside
Leaves	((a-L rhamnosyloxy) benzyl) carbamate	Glucosinolate
Seeds, leaves, stem and roots	Quercetin	Flavonoid
Roots and flowers	Pterygospermin	Glycoside

Nutrient Potential

M. oleifera contains more than 90 nutritional chemical compounds, including proteins, lipids, Carbohydrates and dietary fibbers. It is used in the tropics as a food source to overcome malnutrition, especially in children and infants. Among the several nutrients found in different parts of *M. oleifera*, proteins are the most abundant, accounting for approximately 25% of dry weight, and at least 19 amino acids have been identified in this plant. Furthermore, *M. oleifera* also contains several minerals and vitamins. Lipids are abundant in seeds, mainly stearic acid, saturated palmitic acid and oleic acid. The lipid compounds linolenic acid and palmitic acid are the main constituents of *M. oleifera* leaves. In addition, the high nutritional content found in dried leaves is an indicator of the usefulness. In addition, the high nutritional content found in dried leaves is an indicator of the usefulness of the plant as a food resource.

Table 2: Nutrient Potential

Principle	Nutrient value-Pods	Nutrient value-Leaves
Energy	37 Kcal (2%)	64 Kcal (3%)
Carbohydrates	8.53 g (6.5%)	8.28% (6%)
Protein	2.10 g (4%)	9.40 g (17%)
Total Fat	0.20 g (1%)	1.40% (7%)
Cholesterol	0 mg (0%)	0 mg (0%)
Dietary Fiber	3.2 g (8%)	2.0 g (5%)
Vitamins		
Folates	44 µg (11%)	40 µg (10%)
Niacin	0.680 mg (4%)	2.220 mg (14%)
Pyridoxine	0.120 mg (9%)	1.220 mg (92%)
Riboflavin	0.074 mg (6%)	0.660 mg (51%)
Thiamin	0.053 mg (4.5%)	0.257 mg (21.5%)
Vitamin A	74 IU (2.5%)	7564 IU (252%)
Vitamin C	141 mg (235%)	51.7 mg (86%)
Electrolytes		
Sodium	42 mg (3%)	9 mg (0.5%)
Potassium	461 mg (10%)	337 mg (7%)
Minerals		
Calcium	30 mg (3%)	185 mg (18.5%)
Iron	0.36 mg (4.5%)	4.00 mg (50%)
Magnesium	45 mg (11%)	147 mg (37%)
Phosphorus	50 mg (9%)	112 mg (20%)
Selanium	8.2 µg (15%)	0.9 µg (1.5%)
Zinc	0.45 mg (4%)	0.60 mg (5%)

Bioactive components in leaves protect against several diseases

Hypolipidemic Effects: Many bioactive compounds found in Moringa leaves may influence lipid homeostasis. Flavonoids, as well as Phenolic compounds, have important roles in lipid regulation. They are involved in the inhibition of pancreatic cholesterol esterase activity, thereby reducing and delaying cholesterol absorption, and binding bile acids, by forming insoluble complexes and increasing their fecal excretion, thereby decreasing plasma cholesterol concentrations (Jimenez *et al.* 2017) [2]. The extracts of Moringa have observed hypolipidemic activity, due to inhibition of both lipase and cholesterol esterase, thus showing its potential for the prevention and treatment of hyperlipidemia**.**

Antioxidant Effects: Due to the rich concentrations of antioxidants present in Moringa leaves, they can be used for patients with inflammatory conditions, including cancer, hypertension, and cardiovascular diseases. The carotene is mainly found in MO leaves has been shown to act as an antioxidant (Jimenez *et al.* 2017) [2].

1.

2. **Anti-Inflammatory and Immunomodulatory Effect:** The extracts of MO leaves stimulated both cellular and humoral immune responses in cyclophosphamide-induced immuno deficient mice, through increases in white blood cells, percent of neutrophils and serum immuno globulins. In addition, quercetin may have been involved in the reduction of the inflammatory process by inhibiting the action of neutral factor kappa-beta (NF-k) and subsequent NF-kB-dependent downstream events and inflammation. Further, the fermentation of MO appears to enhance the anti-inflammatory properties of MO. C57BL/6 mice, fed for 10 weeks with distilled water, fermented and non-fermented MO. Investigators reported decreases in the mRNA levels of inflammatory cytokines and reductions in endoplasmic reticulum stress in those animals fed the fermented product (Gupta *et al.* 2010).

3. **Hepato-Protective Effects**: The methanol extract of moringa leaves has a hepatoprotective effect, which might be due to the presence of quercetin. MO leaves have been shown to reduce plasma ALT, AST, ALP, and creatinine and to ameliorate hepatic and kidney damage induced by drugs (Jimenez *et al.* 2017) [2].

Anti-diabetic properties: Moringa has been shown to cure both Type 1 and Type 2 diabetes. Type 1 diabetes is one where the patients unable to produce insulin, which is a hormone that maintains the blood glucose level at the required

normal value. Type 2 diabetes is 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 (Gopal krishna *et al.* 2016). Several studies have shown that moringa can act as an anti-diabetic agent.

Anticancer properties

Now, Cancer is a common disease and one in seven deaths is attributed due to improper medication. Many cancer treatments like surgery, chemotherapy and radiation are highly expensive and have side effects. *M. oleifera* can be utilized as an anti-cancer agent as it is natural, reliable and safe, at established concentrations. Experiments have shown that moringa can be used as an anti-neoproliferative agent, thereby inhibiting the growth of cancer cells. Soluble and solvent leaf extracts have been proven as 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. Furthermore it is proved by the up-regulation of caspase 3 and caspase 9, which are part of the apoptotic pathway. Moreover, the ROS production by moringa is specific and targets only cancer cells, making it a perfect anticancer agent (Gopal Krishna *et-al* 2016).

Other Diseases

Moringa can be used as a potent neuroprotectant. Cerebral ischemia is caused due to the obstruction of blood flow to the brain. This leads to reperfusion and lipid peroxidation, which in turn results in reactive oxygen species. Moringa having antioxidants can reduce the reactive oxygen species, thereby protecting the brain. *M. 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 acetylcholine esterase activity, thereby improving cholinergic function and memory. Moringa is prescribed by herbal practitioners for patients infected by AIDS (Gopal krishan *et al*. 2016). Moringa is recommended to be included in the diet, with the view of boosting the immune system of HIV positive individuals.

Conclusion

Based on the review study on Immunostimulatory potential in Moringa oleifera we can conclude that moringa is a highly nutritious vegetable among all the vegetables. Not only fruit even leaves, flowers and each part of the plant are highly nutritious. As it's having Vitamins A, B, C, D, E as well as minerals including calcium, iron, magnesium, potassium, selenium and different nutrient components makes it extremely important. The chemical constituents of morning are highly potent to boost the immune system. Moringa can be used as an energy booster, healing agent, Antibacterial agent and having great potential to cure several diseases. As it is highly nutritious, moringa should be included in the human diet.

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