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Review Article

Moringa oleifera: A Miraculous Plant to Combat Malnutrition

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Abstract

Moringa Oleifera is a multi-nutrients plant that is mostly grown in tropical and subtropical territories of the world and belongs to family Moringaceae. It is also known as Drumstick and marvel tree. *Moringa Oleifera* is a treasure of nutrients gifted to humans by nature. Malnutrition is a serious and prevailing problem effecting people all over the world especially in developing countries. A significant proportion of people are malnourished in the world. *Moringa Oleifera* have potential to overcome malnutrition. Each of its part is rich of nutrients. Its leaves, seeds, pods, flowers and roots are source of protein, vitamins e.g., vitamin A, Vitamin B-complex, vitamin C and vitamin E vice versa and minerals specifically (calcium, iron, potassium, zinc) Moringa Oleifera have nutritional as well as therapeutic properties for people of all ages. *Moringa Oleifera* provide more nutrients than fruits and vegetables. *Moringa Oleifera* leaves are used to treat to protein energy malnutrition (PEM). These leaves have been used to fortify biscuits and other food products to enhance their nutritional content to prevent malnutrition. Moringa Oleifera milk powder consumption results in weight gain in children. Supplementation e.g., with *Moringa Oleifera* plant is a strategy to overcome micronutrients deficiency. *Moringa Oleifera* is a super food and a cost-effective tool for combating malnutrition for under developing countries. It is a novel food with nutritional benefits. It is used as a substitute of iron supplements in treating anemia particularly menstrual cycle associated anemia and improves iron status. Moringa nachos and moringa khakhra are made using Moringa Oleifera powder for the nutritional benefits to combat malnutrition.

Keywords: *Moringa Oleifera*; Malnutrition; Anemia; Supplementation

Introduction

Malnutrition is not a problem of any single country, but a global problem. It is increasing day by day in the world despite of rapid advancement, effecting not only children but also people of all ages and all over the world. Malnutrition exists in two forms: under-nutrition (stunting, wasting, etc.) and over-nutrition (overweight, obese, etc.). Inadequate intake of nutrients makes people prone to developing diseases and causing deaths. Malnutrition outcomes continue to effects the individuals through their entire life, influencing cognition, growth, development and economy. Malnutrition can be prevented bytaking a balanced diet (containing macronutrients and micronutrients) and regular exercise. Malnutrition is prevalent

in all ages particularly in adolescent. Infectious and metabolic diseasesare more common in malnourished adolescents particularly in adolescent girls. Besides this, malnutrition also has great effect on intellectual capabilities and performances of people in daily routine [1,2]. A plant named *Moringa Oleifera*, is known to plays role in overcoming and preventing malnutrition. *Moringa Oleifera* is a treasure of nutrients. This plant is also known as "Mother's Best Friend" and"Miracle Tree "due to its nutritional and therapeutic benefits. It is used as a supplement to combat malnutrition. It is a multi-nutrient plant that is gifted by nature to humans [3]. It contains proteins providing essential amino acids, carbohydrates, vitamins and minerals like potassium, iron, calcium and phosphorus. It is also known as miracle tree as it can also be used to cure diseases; besides providing macro nutrients as well as micronutrients. Its mature seeds, leaves, oil extracted from the seeds, flowers, pods etc. can be used for overcoming malnutrition as essential phytochemicals are present in the leaves, pods and seeds of moringa. It contains nutrients which play a role in maintenance of body thus improving the nutritional status [4] Malnutrition is majorly contributing to morbidities and mortalities in the world. 45% of mortalities in children under 5 years of age are due to malnutrition in third world countries.[5] A significant proportion of population is undernourished. 821 million of people are undernourished, 151 million of children under 5 years of age are low height for age (stunting), 631 million women and girls between age group 15-49 years are iron deficient. *Moringa Oleifera* is capable of overcoming these micronutrients deficiencies [6].

Moringa Oleifera

Malnutrition is a globally prevailing and serious problem. Undernutrition, a form of malnutrition,that exist when the intake of nutrients is not sufficient or meet the requirements of the body leading to health problems e.g., mental retardation, lack of proper physical growth. *Moringa Oleifera* has potential to combat malnutrition. It is usually grown in subcontinent, tropical and subtropical regions of the world. Its leaves provide us protein particularly sulphur containing amino acids which can used to treat protein energy malnutrition (PEM). The micronutrients content of *Moringa Oleifera* plant is high. It provides more vitamin A than carrots, more vitamin C content than oranges, more calcium than milk and high amount of potassium than bananas. Itmeans that it can improve eyesight, scurvy, bone related problems and hypertension respectively thus improving the nutritional status of individuals. *Moringa Oleifera* is a good source of iron andfiber as well thus preventing and treating anemia and constipation as it provides 9 times greateramount of iron as spinach and 4 times greater amount of fiber than oats [7,8]. *Moringa Oleifera* leaves in dried form as a powder provide us more nutrients as compared to its fresh leaves. *Moringa Oleifera* powder has ability to improve the nutritional status of malnourished people including children if it is used on regular basis. Its leaves not only provide protein us but also provide us natural antioxidants particularly flavonoids and phenolic acids thusplaying role in reducing oxidative stress. Its leaves are good source of antioxidants then its flowersand seeds. Antioxidants help to prevent the free radicals damage in the body by decreasing oxidative stress which ultimately improve our health status as well as nutritional status. *Moringa Oleifera* has been declared by world health organization (WHO) as a substitute to imported foodproducts supplements to combat malnutrition. *Moringa Oleifera* provide 96 nutrients and 46 antioxidants. *Moringa Oleifera* usage, in either juice form, or fresh or dry leaves powder form, provide nutrients andcan combat malnutrition particularly in pregnant and lactating ladies and in young children. *Moringa Oleifera* canbe used as alternative to iron supplements to cure anemia.*Moringa Oleifera* flowers tea has potential of increasing iron levels of pregnant ladies preventing anemia and increases breast milk production in lactating women. It cantreat PEM in children as well as improves the health and nutritional status (by increasing weight) of children [9].

Chronic malnutrition is a problem prevailing in children in Zambia. A study was done in Zambia on girls to improve their nutritional status in girls by using Zambian *Moringa Oleifera* powder. Vitamins and minerals (micronutrients) deficiencies have influence on health of children too. Malnutritionleads to weak immune system which renders children vulnerable to developing diseases e.g., enteric infections, respiratory infection, etc. Malnutrition leads to enteric infections e.g., diarrheawhich further contribute to malnutrition. Their nutritional status is further compromised. Children suffer from deficiencies of many macronutrients and micronutrients specifically vitaminA, iron, etc. Dietary intake alone is insufficient to meet the nutritional requirements. Micronutrients supplementation can overcome nutrients deficiencies. Besides this, in case of chronic malnutrition, particular food can be combined with plants that contain nutrients e.g., *Moringa Oleifera* plant. This plant has multiple nutritional benefits. *Moringa Oleifera* grows in tropical and sub-tropical areas of the world. It is a good source of proteins,

vitamins and minerals.*Moringa Oleifera* in powdered form is used for combating malnutrition [10].

Nutritional status is the predictor of human income. Toddlers are particularly vulnerable to develop nutritional deficiencies and health problems if their nutritional requirements are not met. Insufficient intake of nutrients leads to malnutrition which in turn effect our health particularly brain health e.g., decreased IQ, cognitive development and sensory integration.

As *Moringa Oleifera* leaves provide many minerals and vitamins, that are important for the normal growth and development as well as they can raise the nutritional status in malnourished children. *Moringa Oleifera* leaves have potential to improve the nutritional status. So, they can used to fortify food products other than biscuits e.g. yogurt, soy meatballs, etc. to the nutrition content of these food products which in turn will improve the nutritional well-being of children and otherindividuals [11].

Malnutrition is a cause of diseases and deaths in children under 5 years of age in developing countries. Malnourished children are at increased risk of mortality than children having adequatenutritional status. Maternal nutritional status has a great influence on their children nutritional status. Researchers suggest that in a malnourished (underweight) pregnant lady, chances of fetusborn becoming overweight and obese are increased which make them vulnerable to suffer fromnon-communicable chronic diseases e.g., cardiovascular diseases, diabetes, etc. later on in their life. Supplementary feeding initiated by government to overcome the nutritional deficiencies and improves nutritional status of children in Indonesia. BIMA-X products (Biscuits and *Moringa Oleifera* leaves extract) is given to children to combat malnutrition. Results of this study shows that fortification of biscuits with *Moringa Oleifera* leaves extract improved the nutritional and health status of children [12].

Different parts of *Moringa Oleifera* such as mature seeds, oil extracted from the seeds, leaves, roots, flowers, pods (pods husks) etc. can be used to combat malnutrition. Each part has particular benefits and nutrients content.

- **Seeds:** They are rich source of antioxidants e.g., beta carotene, vitamin C, vitamin A, flavonoids, quercetin and anthocyanin etc. Increased oxidative stress leads towards early aging and onset ofdiseases. Antioxidants consumption decrease oxidative stress in our body. Its mature seeds provide oil such as mono-unsaturated fatty acids, especially oleic acids. Increased consumption of monounsaturated fatty acids reduces coronary heart problems chances thus maintaining normal body functioning. Its seeds also provide polyunsaturated fatty acids e.g., oleic acid, linoleic acids, etc. which helps to maintain cholesterol level which make them alternative of oliveoil.
- **Leaves:** They provide antioxidants, as provided by seeds, as well as vitamins and minerals. They are good source of proteins and essential amino acids. Leaves can be taken in dried and fresh form. Nutrient content of leaves increases when they are used in dried from. They can be consumed as a vegetable, in powdered form, in juice or tea form, etc. They provide more macronutrients and micronutrients content than fruits, vegetables and dairy sources. Its powdered can be used as a supplement to improve the nutritional status in malnourished people.The calorie content of leaves is low thus they can be used as low-caloric food component in dietby overweight and obese persons. *Moringa Oleifera* nutritional Properties and its prospect results those daily usages of*Moringa Oleifera* leaves powder in meals of children for two months improved their nutritional status, this it is used for over-coming malnutrition and nutrients deficiencies.
- **Roots:** *Moringa Oleifera* roots play a role in maintenance of nutritional status through improvinggastrointestinal tract health. It treats gastric ulcers and heals lesions of gastric mucosa.
- **Flowers:** They are good source of iron. They have potential to improve iron status in individuals.Thus, they are useful for treating anemia and can stimulate milking/breast milk production in lactating women.
- **Pods husks:** They are used for nutritional benefits that they provide. They are good source of tannins, antioxidants e.g., flavonoids, etc. and alkaloids. They show antimicrobial properties against some gram-positive bacteria e.g., S. epidermidis and gram-negative bacteria e.g., K. pneumonia. Pods provide fiber which makes pods valuable in preventing and treating constipation and treatment of cancer of colon. They are useful for healthy gut, which in turn improve the digestion and absorption of nutrients and helps to maintain nutritional status [12].

The macronutrients and micronutrients content of different parts of *Moringa Oleifera* (per 100gram) plant are given in table.

Moringa Oleifera is a good source of vitamins e.g., vitamin A, B vitamins, vitamin C, vitamin D, vitamin E etc. which are essential for normal body functioning and maintaining nutritional status. Vitamin C (a water-soluble vitamin) and vitamin E (fat soluble vitamin) can improve functioning of brain as well as neurotransmitter normalization e.g., dopamine, noradrenaline and serotonin due to their antioxidants and neuro enhancer activities. These neurotransmitters play a role in refreshing mood, proper functioning of organs, mental health and memory retention. *Moringa Oleifera* provides us many minerals which play important role in normal

Nutrients	Fresh leaves	Dry leaves	Leaves powder	Seeds	Pods
Protein (g)	6.7	29.4	27.1	35.97	2.5
Fat (g)	1.7	5.2	2.3	38.676	0.1
CHO (g)	12.5	41.2	38.2	8.67	3.7
Fiber (g)	0.9	12.5	19.2	2.87	4.8
Vitamin C (mg)	220	15.8	17.3	4.5	120
Vitamin E (mg)	448	10.8	113	751.67	-
Calcium (mg)	440	2185	2003	45	30
Copper (mg)	0.07	0.49	0.57	5.20	3.1
Potassium(mg)	259	1236	1324	-	259
Iron (mg)	0.85	25.6	28.2	-	5.3
Sulphur (mg)	-	-	870	0.05	137

Table a

body functioning e.g., calcium, iron, potassium, zinc, etc. Calcium (Ca) is an important mineral for our bones and teeth.Iron (Fe) performs multiple roles in our body particularly RBCs production, growth and development thus Fe deficiency can cause microcytic anemia. *Moringa Oleifera* treats anemia by increasing Fe levels in our body. Potassium (K) has a role in lowering blood pressure as *Moringa Oleifera* provides more potassium than bananas. Zinc (Zn) plays role in sperm growth as well as essential for nucleic acid (DNA or RNA) synthesis. All these vitamins and minerals have a role in maintaining nutritional well-being. (Kantilata Thapa, *Moringa Oleifera*: Nutritional Properties andits Prospect in the Context of Nepal, 2019).

Moringa Oleifera, a multi nutrients plant, has been recommended it as a substitute food to combat malnutrition. Moringa leaves are used as a supplement for stimulating milk production in lactating mothers and in infants. Malnutrition is prevalent in children in Moluccas where natural food products are abundant. Moringa milk powder has potential to combat malnutrition.A case control study was conducted on children between age group of 1 month and 12 years. 30children, who were in case group, was given malnourishment treatment with moringa milk powder and the second group was control group which also include 30 children, was given malnourishment treatment alone. Their anthropometric measurement (weight, height, etc.) wastaken for three months. They were given *Moringa Oleifera* milk powder to improve their malnourishment. Daily consumption of moringa milk powder for a period of two months resultedin weight gain in children [13].

Different strategies are used to combat malnutrition. Supplementation is a strategy that is used to overcome hidden hunger. "Drumstick", "debeday" and "miracle tree" are different names of *Moringa Oleifera* tree. *Moringa Oleifera* leaves are used in dried or powdered forms which are used for making different kinds of meal and porridge diets, especially for pregnant ladies, lactating mothers and children because of their nutritional content. Infants are not capable of synthesizing protein to meet their needs. *Moringa Oleifera* leaves are source of two essential amino acids which are arginine and histidine that are requiredfor proper growth and development. Consumption of *Moringa Oleifera* leaves powder provides micronutrients along with protein to children and women. *Moringa Oleifera* leaves are used in anumber of ways in human diet [14].

Each part of *Moringa Oleifera* act as a reservoir of nutrients. Its leaves provide minerals e.g., iron,calcium, zinc, potassium, copper, etc. and vitamins e.g., beta-carotene, B vitamins particularly vitamin B 9, vitamin C and E. These vitamins and minerals are required for normal growth and development. The availability of micronutrients in *Moringa Oleifera* is affected by seasons. Vitamin is present in *Moringa Oleifera* in more amounts in hot and wet season as well as vitaminC and iron is present in abundant amount in cool and dry season. Moringa powder is used as an alternative of iron supplements for improving iron status and curing anemia. *Moringa Oleifera* leaves powder provide more iron than beef. Micronutrients and protein content of different parts of *Moringa Oleifera*

make them useful for combating malnutrition. It is used as an alternate to food supplement to prevent malnutrition in developing countries. *Moringa Oleifera* will act as super food in near future for developing countries [15].

Malnutrition is further being put at risk by COVID-19 pandemic particularly in developing countries. Novel foods have the potential to overcome this malnutrition. *Moringa Oleifera* is a novel traditional food product. *Moringa Oleifera* not only provide nutritional benefits, but also provide cultural and economic gains like other novel food products. *Moringa Oleifera* leaves powder have longer shelf life and act as a tool and cheap supplement to combat malnutrition. *Moringa Oleifera* leaves powder has bitter taste. This powder of *Moringa Oleifera* can be used forfortification of food products e.g., cereals, flour, juices, rice, etc. [6,10].

Moringa is considered as good wound healer. Each part of moringa have specific properties which make them effective for different diseases. *Moringa Oleifera* leaves have properties which are effective againstbacteria, viruses and fungi. They show properties of anti-diabetic, anti-proliferative, immunomodulatory, hepatoprotective and hypocholestromic. *Moringa Oleifera* leaves are effective against bacterial infections, urinary tract infections, dental caries, headache, anemia and cancer. *Moringa Oleifera* flowers are effective against bacterial infection, viral fever, inflammation and tumors. They have diuretic properties. *Moringa Oleifera* seeds are effective against ulcers, gastric inflammation, joints inflammation, common fever, microbes and tumors. *Moringa Oleifera* seeds oil is used for treating scurvy, constipation and dermal infections and hasantioxidant and laxative properties. *Moringa Oleifera* roots have antispasmodic and diuretic properties. They are useful for treating asthma, common cold, toothache, epilepsy, splenomegalyand renal failure. *Moringa Oleifera* is not only capable of overcoming malnutrition, but also capable of treating diseases all over the world [7,10]. Many researches have been done ina number of countries, including India, Indonesia, Philippines, South Africa, etc. on *Moringa Oleifera*. It has a number of health promoting and nutritional benefits. It is used for treating anemia associated with menstrual cycle in females and children. Moringa is a cost effective to combat malnutrition and diseases in developing countries [15]. *Moringa Oleifera* leaves have potential to overcome malnutrition in children in rural areas. The nutritional content of products made from *Moringa Oleifera* is high. Each part of this plant is nutrients rich and can be eaten. A study was done to make nutritious products using *Moringa Oleifera* leaves. Two products was made; moringa nachos and moringa khakhra. Moringa nachoswere made by using maize flour and wheat flour with *Moringa Oleifera* leaves. Moringa khakhrawas prepared by using gram flour and wheat flour with *Moringa Oleifera* leaves. These nutrientsrich products used to overcome malnutrition in rural children [9,13].

Moringa Oleifera is a multi-nutrient plant. It is a natural energy booster. *Moringa Oleifera* leavesare rich in protein and micronutrients content. They provide more micronutrients than milk, fruits and vegetables, and provide protein approximate to eggs and meat. They are good sourceof protein for the people who don't eat animal-based food products. Moringa flowers are good source of calcium and potassium. These flowers find their usage as a vegetable and used for making tea. They are used to meet dietary calcium and potassium needs. Calcium plays a numberof roles in our body. Potassium plays a role in lowering blood pressure. *Moringa Oleifera* is cheapor cost-effective source of nutrients that make it valuable for combating malnutrition [16].

Conclusion

Moringa Oleifera provides macronutrients and micronutrients to combat and prevent malnutrition by improving the nutritional status of malnourished individuals. *Moringa Oleifera* leaves powder has potential to overcome malnutrition. *Moringa Oleifera* leaves have low caloric content which make them a good component of diet ofoverweight and obese persons. Malnutrition makes people vulnerable to different morbidities, which further compromise the immunity and nutritional status. Each part of *Moringa Oleifera* has nutritional as well therapeutic properties. It is an inexpensive plant which is used to provide multiple nutrients to prevent malnutrition. It is one of those rare plants that have a number of nutritional benefits. *Moringa Oleifera* is a reservoir of nutrients. It will act as a super food in nearfuture to prevent malnutrition in developing countries as it has potential to meet the nutritionalrequirements of the body.

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Conflict of Interest

There is no potential risk of interest.

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