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Review Article

Moringa oleifera: a review on nutritive significance and its medicinal application for children

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ABSTRACT

Although native to the Indian subcontinent, the drought-resistant Moringa oleifera has gained significant attention in recent years due to its extraordinary nutritional and medicinal properties. In developing countries, malnutrition still threatens public health and demands integrated approaches to improve the nutritional status, especially among children. In this regard, Moringa oleifera is a powerful tool for enhancing children's nutritional status due to its remarkable amino acid and vitamin, particularly in areas with restricted access to a wide variety of nutrient-dense foods. It is also rich in iron content and other essential nutrients needed for iron metabolism; thus, Moringa trees have been employed in developing tropical countries to alleviate malnutrition and treat childhood diseases such as iron deficiency anaemia. This review highlights the nutritional value of Moringa oleifera and its therapeutic uses for children.

Keywords: Moringa, Anaemia, Children, Nutrition, Amino acids

INTRODUCTION

Moringa oleifera, often called the "miracle tree," has gained significant attention in recent years due to its extraordinary nutritional and medicinal properties.[1] This fast-growing, drought-resistant tree is native to the Indian subcontinent, but it is now grown all over the world, especially in tropical and subtropical areas.[2] The leaves, pods, seeds, and roots of the Moringa tree are edible and have been used for ages in traditional medicine to cure various illnesses. Even flowers make a tasty tea and are a rich source of potassium and calcium.

Children require a balanced intake of macronutrients and micronutrients to support their rapid growth and development. Unfortunately, malnutrition contributes to poor health outcomes and increased vulnerability to disease, and it is still a significant public health concern in many parts of the world. WHO data estimates that 19% of the 10.8 million child deaths globally a year are attributable to iodine, iron, vitamin A, and zinc deficiencies.[3,4] In this context, *Moringa oleifera* presents itself as a potent tool for improving the nutritional status of children, especially in areas with restricted access to a wide variety of nutrient-dense foods. Moringa trees have been employed in developing tropical countries to alleviate malnutrition, particularly in young children. This review aims to analyse the nutritional value of *Moringa oleifera* and its therapeutic uses for children. We emphasize the plant's potential involvement in enhancing child health outcomes by analyzing its nutritional composition, health benefits, and therapeutic qualities.

NUTRITIVE SIGNIFICANCE OF *MORINGA OLEIFERA*

The leaves of the *Moringa oleifera* plant are rich in minerals, vitamins, and plant proteins. It increases

enzyme activities and has a role in protein production as a ligand for DNA sequence promoter for DNA transcription in children's development.[5] *Moringa oleifera* is exceptionally rich in macronutrients, making it a valuable addition to the diet, especially in regions where food security is a concern.

PROTEIN CONTENT AND AMINO ACID PROFILE

With a protein content of between 27 and 30 percent by dry weight, the leaves constitute a highly nutritious protein source.[6] This is notably higher than most plant sources, making Moringa an excellent alternative to animal proteins, particularly for vegetarian and vegan diets.

Moringa leaves contain all of the essential amino acids in significant amounts, which are quite uncommon in other vegetables. Arginine and histidine, two amino acids particularly crucial for newborns, are also found in Moringa .[7]

VITAMIN AND MINERAL COMPOSITION

Moringa oleifera is often described as a “superfood” owing to its high quantities of essential vitamins and minerals. The leaves are an excellent source of vitamin A (four times the amount in carrots), crucial for maintaining healthy vision, immune function, and skin health. Additionally, they have a lot of vitamin C (seven times as much as oranges), a strong antioxidant that boosts the body's defenses against disease and improves the absorption of iron.[8,9]

Iron content in Moringa leaves is particularly remarkable, with levels comparable to or even higher than those in spinach. This makes Moringa a valuable dietary component for preventing and treating anaemia, particularly in children. Calcium is another abundant mineral in Moringa, essential for bone development and maintenance.[9] The leaves contain more calcium per gram than milk (Seventeen times more calcium than milk), making them a highly beneficial food for growing children. Other essential minerals found in Moringa include potassium, magnesium, and zinc, all of which play vital roles in maintaining bodily functions.

ANTIOXIDANT PROPERTIES AND PHYTOCHEMICALS

In addition to macro- and micronutrients, Moringa oleifera has a variety of bioactive substances that support its health-promoting properties. These include flavonoids, phenolic acids, and isothiocyanates, which have been shown to possess antioxidant, anti-inflammatory, and anticancer properties.[10]

Moringa leaves are rich in flavonoids, a class of antioxidants. Quercetin, a flavonoid found in Moringa leaves, is known for its ability to reduce blood pressure and act as an anti-inflammatory agent. Chlorogenic acid, another compound in Moringa, helps regulate blood sugar levels and has potential antidiabetic effects.[10]

Moringa has approximately 46 antioxidants, one of the most potent natural anti-oxidant sources. Quercetin, Kaempferol, Beta-Sitosterol, Caffeoylquinic acid, and Zeatin are the major antioxidants found in Moringa. Consuming *Moringa oleifera* daily will supply the antioxidant that protects the body from harmful effects resulting from fat deposition, maintaining overall health.

Anti-oxidants supply the free atoms the human body needs and mitigate the impact of free radicals. This antioxidant property helps in preventing the formation of malignancy. These antioxidants protect cells from oxidative damage linked to various chronic diseases.

For children in a critical stage of growth and development, the antioxidant properties of Moringa can help safeguard their developing bodies from potential damage caused by environmental stressors and poor dietary habits.[11]

MEDICINAL APPLICATIONS

Treatment of malnutrition and growth promotion

The elements calcium and phosphorus, essential for healthy bones and teeth, are abundant in Moringa oleifera and must be consumed in sufficient amounts during childhood to reach optimum bone mass. Phosphorus works alongside calcium to preserve bone density and strength.[9]

In addition to calcium and phosphorus, Moringa contains magnesium, which activates vitamin D in the body. Vitamin D is necessary for calcium absorption, further emphasizing the importance of Moringa in supporting healthy bone development. Enough consumption of these minerals is essential for developing infants to avoid diseases such as rickets, which cause weakening bones, malformations, and delayed growth.[3]

Management of diarrhoea and gastrointestinal disorders

Moringa oleifera's high fiber content facilitates digestion and supports intestinal health.[12] Fiber is essential for regular bowel motions and prevents youngsters from constipation, a common problem. Additionally, it encourages the development of good gut flora, which is vital for healthy digestion and general well-being.

Compounds found in Moringa leaves have been demonstrated to have anti-ulcer qualities; these can shield the lining of the stomach and lower the risk of gastritis and other digestive problems. Moringa can ensure that children get the nutrients they require from their food,

which is crucial for growth and development, by supporting digestive health.

Anti-inflammatory and immune modulating effects

The immune system-boosting properties of Moringa oleifera are among the most important benefits for children. The immune system is supported by the high levels of vitamins A and C found in Moringa leaves in several ways. Also, it promotes white blood cell synthesis and function, which is necessary for combating infections. Robust immune systems are essential for children to fight off common diseases like the flu, colds, and other respiratory ailments.[13]

Regular consumption of Moringa can help reduce the incidence of illness in children, particularly in environments exposed to various pathogens. On the other hand, Vitamin C is also responsible for synthesizing collagen, a protein that aids in maintaining the structure of skin and other tissues.[14]

While inflammation is an inevitable response to an injury or infection, chronic inflammation can cause several health issues, such as autoimmune disorders, asthma, and allergies. As Moringa oleifera has a high concentration of flavonoids, isothiocyanates, and other bioactive components, it has been demonstrated to have substantial anti-inflammatory properties.[13,14]

Potential in treating childhood diseases

Asthma is a common chronic respiratory condition in children, characterized by inflammation and narrowing of the airways, leading to difficulty breathing. Moringa oleifera, with its anti-inflammatory and bronchodilator properties, has been studied for its potential role in managing asthma.

Research suggests that Moringa leaf extracts can help relax the bronchial muscles, making breathing easier. Additionally, its anti-inflammatory effects can reduce the frequency and severity of asthma attacks. While more clinical research is needed, the existing evidence supports using Moringa as a complementary treatment for asthma in children.

TREATMENT OF ANAEMIA

The primary cause of anaemia in children is iron deficiency, which might result in symptoms such as weakness, exhaustion, and impaired cognitive ability. Because of its exceptionally high iron content, Moringa oleifera is an effective remedy for treating and preventing anaemia in children. Vitamin C also boosts iron bioavailability in Moringa, facilitating the body's absorption of iron. Moringa can aid anaemic children's haemoglobin levels, energy levels, and general well-being when consumed regularly.

Moringa oleifera as a complementary food for children

A 100 g serving of freshly cooked leaves would provide all the calcium, almost 75 percent of the iron, half the protein required, and substantial amounts of potassium, B vitamins, copper, and all the key amino acids recommended daily for a child aged 1-3. A child might receive all the vitamins A and C he requires from as little as 20 g of leaves.[1]

Leaf powder

Because of its extended shelf life and ease of use, Moringa leaf powder is one of the most widely used forms of Moringa oleifera. The leaves from the Moringa plant are dried and then crushed into a fine powder. Smoothies, soups, sauces, and baked goods are just a few of the foods and beverages to which they can be effectively added. For children, Moringa powder can be mixed into veggies, rice, yogurt, or porridge.[15]

Capsules and tablets

Furthermore, Moringa is available in tablet and capsule form, which is convenient for ensuring consistent intake. Older children who may dislike the distinctive taste of Moringa powder can benefit from this form. Typically manufactured from powdered Moringa leaf, the capsules and tablets can be consumed with juice or water.

The recommended dose for tablets and capsules is typically the same as for leaf powder. Nevertheless, it is imperative to adhere to the manufacturer's recommendations and seek medical advice, particularly for young children.

Fresh leaves and pods

Fresh leaves and pods of Moringa oleifera are often used in culinary applications in the areas where it is cultivated. While the pods are usually cooked and consumed as a vegetable, the leaves can be mixed into soups, stews, and salads. Fresh leaves can have the same beneficial effect on health as powdered Moringa since they are abundant in nutrients.[16]

Children may consume meals that include blanched fresh Moringa leaves. The tender pods can be cooked and served as a nutritious meal. Fresh Moringa is an amazing option for people who can access it because it preserves its entire nutritional profile.

DOSAGE RECOMMENDATIONS AND SAFETY

The adverse effects of taking 20 g of powdered Moringa leaf daily have been documented to include nausea; a safety consumption limit of 70 g/day is recommended to avoid the toxicity of harmful elements and cumulative toxicity from extended use.[17]

It's crucial to start small with a dosage of Moringa oleifera for children and increase it gradually as tolerated. For young children, starting with a quarter teaspoon of Moringa powder daily and gradually increasing to one teaspoon is a safe approach. For older children, beginning with one teaspoon and increasing to one tablespoon is typically recommended. It's essential to monitor the child's reactions to Moringa as some children may be intolerant to its flavour or effects. Parents and caregivers should consult a pediatrician before introducing Moringa, especially if the child has any underlying health conditions or is taking medication.

PUBLIC HEALTH SIGNIFICANCE

Conducting clinical trials

Most studies on Moringa's effects have been conducted on small populations, and there is a need for more extensive, well-controlled trials to confirm its dosage, efficacy, and safety in children. While the nutritional benefits of Moringa are well-documented, more research is needed to understand its long-term effects, mainly when used as a supplement in children's diets. Further studies should also explore the potential interactions between Moringa and other foods or medications.

Integration with existing healthcare systems and policies

Initiatives that incorporate Moringa in community gardens, school meals, and food aid programs have demonstrated potential in treating deficiencies in some micronutrients as well as improving general nutritional status. Initiatives to incorporate Moringa in school meals have already started in certain countries, and the results have been promising.

Education and awareness campaigns for caregivers and healthcare providers

Despite its potential, there are challenges to the widespread adoption of Moringa oleifera in public health and nutrition programs. These include limited awareness of Moringa's benefits, cultural preferences for other foods, and logistical issues related to cultivation, harvesting, and distribution. To overcome these challenges, efforts should be made to raise awareness about Moringa's nutritional and medicinal properties through education and outreach programs. However, research about more efficient cultivation and processing methods could help make Moringa more accessible and affordable for needy communities.

Long-term effects and potential side effects in children

Moringa oleifera is generally considered safe for consumption, but like any supplement, it should be used in moderation. High doses of Moringa, particularly from the root or bark, can be toxic due to the presence of alkaloids and other compounds that can cause adverse effects. However, the leaves, seeds, and pods, which are most commonly used, are safe for consumption in recommended amounts. For children, it is crucial to adhere to the recommended dosage guidelines to avoid potential toxicity. While Moringa is unlikely to cause harm when consumed in typical dietary amounts, excessive intake may lead to digestive issues, such as nausea, diarrhoea, or stomach cramps.

Interactions with other medications

Certain medications, especially those that impact blood pressure, blood sugar levels, or thyroid function, may interact with Moringa oleifera. For children taking such medications, it is essential to consult a healthcare professional before introducing Moringa to ensure no adverse interactions.

Future directions

Possible approaches for exploring the potential benefits of Moringa in public health include chronic illness prevention, maternal health, and environmental sustainability. Moringa has the potential to become a key component for sustainable nutrition and health policies on a global scale as interest in it improves.

CONCLUSION

Moringa oleifera also goes by many other names, including "drumstick tree," "miracle tree," and "horseradish tree." It continues to be one of the most useful and hardy plants, with interest in the plant spreading globally because of its high nutritional and pharmacological value. This review therefore focuses on the nutritive and therapeutic potentials of Moringa oleifera with regard to application in supporting the health of children. The leaves, seeds, and pods of Moringa contain high concentrations of essential nutrients, antioxidants, and bioactive compounds useful in child development and immune function.

Nutritionally, Moringa is a powerhouse of vitamins, minerals, amino acids, and antioxidants, making it a natural, economic supplement to facilitate the classic child deficiencies in underdeveloped areas. Moringa leaves, for instance, are rich in vitamins A, C, and E, important for immune function, vision, and protection against cell destruction, respectively.

Iron content in the leaves of Moringa is also high and might be a vital component in combating anaemia prevalent health issue among children worldwide. Additionally, Moringa contains calcium and magnesium-both important minerals to bone health and physical growth during childhood. These are but a few factors that make Moringa almost a super dietary additive for those specific parts of the world where nutritionally dense foods are either unreachable or just too expensive.

Medicinally, *Moringa oleifera* has been found to possess outstanding anti-inflammatory, antimicrobial, and antioxidant properties that are useful in offering therapeutic support against various ailments during childhood. It was revealed in research studies that the bioactive compounds of Moringa, like quercetin, kaempferol, and chlorogenic acid, have been of importance in combating oxidative stress, one of the contributors to diseases and developmental complications in children.

Moringa's anti-inflammatory properties may be helpful for kids who suffer from infections or inflammation-related diseases quite often, as it has the ability to modulate their immune response and add to their resistance against vectors of disease. Moringa extracts have, in fact, been the subject of many studies that have proved them effective in the treatment of infections brought about by bacteria, viruses, and fungi. Added to these, the anti-parasite property of Moringa is so important, where their children are more exposed to parasitic infections related to malnutrition and slow development.

Moringa oleifera is particularly very attractive because it is an affordable and accessible plant, especially to low-income families or communities with minimal health care services and a balanced diet. As Moringa might be grown in a range of various environments, it becomes a sustainable means to improve the health of children and amend large-scale malnutrition in a cost-effective way. The promotion of Moringa cultivation and use through various methods via community health programs and education would provide greater awareness and encourage routine consumption of the superfood among vulnerable populations in order asking them to help in reducing health disparities and benefiting from long-term improvements in children's health.

Moringa oleifera is turning out to be a powerhouse in nature that proves quite constructive in tackling malnutrition, enhancing immune health, and preventing a wide range of diseases that manifest themselves among children. Its nutrient-rich profile with medicinal properties makes it a very effective and sustainable means of improving the health outcomes of children, particularly in regions challenged nutritionally.

While further clinical studies are still needed to standardize the use of Moringa and provide confirmation of dosage recommendations for children, the bulk of evidence up until now strongly argues in support of its incorporation into dietary and medicinal interventions. Addition of Moringa into children's diets, either as supplementation or by direct consumption of leaves, seeds, or pods, might be one of those game-changing global public health measures that get passed down to healthier and more resilient generations.

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