

Moringa oleifera: Could this be an Answer to our Need for an Alternative to Fighting Drug-Resistance and Chronic Infections?

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Each year, the Center for Disease Control and Prevention (CDC) spend a substantial amount of time and resources to help fight the war on antibiotic resistance. This agency has focused a lot of its attention on education and reducing the use and unnecessary prescribing of these drugs. Over the past 25 years, the development of new antimicrobial drugs is dwindling, while the development of resistance to human or food animal therapeutic agents continue to double [1]. The use of sub-therapeutic levels of antibiotics in animal feed in recent years has raised concern about the development of resistant pathogens in animals and their transfer through food to humans, and placed pressure on meat producers to eliminate the use of antibiotics in food animals. As such, there is increased interest in identifying substances that can reduce the use of in-feed sub-therapeutic antibiotics. Nutraceuticals, or natural supplement that promotes animals' defense against infection and disease can serve as a suitable substitute for the antibiotics.

A huge body of work has been performed on a medicinal plant called *Moringa oleifera*. This plant has shown to be promising in helping combat multiple drug resistant bacteria, chronic and acute infections lowering cholesterol, among others.

Moringa oleifera Lam. (drumstick tree, horse-radish tree), a member of the family Moringaceae, is a small-medium sized tree, 10-15 m high, widely cultivated in East and Southeast Asia, Polynesia and the West Indies. It is an angiosperm plant; its various parts have been utilized throughout history as food and medicine [2]. A wide variety of medicinal and nutritional virtues have been attributed to its roots, bark, leaves, flowers, fruits, and seeds [3,4].

Fuglie [5] reported the many uses for *Moringa* like: alley cropping, animal forage, biogas, domestic cleaning agent, fertilizer, foliar nutrient, green manure, gum, honey- and sugar cane juice-clarifier, honey, medicine, biopesticide, pulp, rope, tannin for tanning hides and water purification. *Moringa oleifera* is considered as an important food commodity in certain parts of the globe, 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 [6-8]. Plant leaves have been reported to be a rich source of β -carotene, protein, vitamin C, calcium and potassium, which act as a good source of natural antioxidants. The leaves are highly nutritious, being a good source of protein, β -carotene, vitamins A, B, C and E, riboflavin, nicotinic acid, folic acid, pyridoxine, amino acids, minerals and various phenolics compounds [8]. *Moringa* is truly a rare plant it has the potential to provide nutrition, medicine, oil (body and cooking), and be a purification agent. The whole plant is also edible from the leaves to the roots [9,10]. The *Moringa* plant is used to combat malnutrition. *Moringa*'s leaves, flowers, young pods, are eaten as vegetables. The pods contain all twenty essential acids, vitamins, and other minerals [10]. The leaves have been shown to be good source vitamins A (more β -carotene than carrots), vitamin C (seven times the amount in oranges) as well as vitamin B and other minerals. In addition the *Moringa*- leaves have three times the amount of potassium provided by bananas, four times the calcium and two times the amount of protein found in milk, and three times the amount of iron provided by almonds (www.moringasource.com) [10]. It is also used to enhance

the shelf-life of fat containing foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [11,12]. The most interesting fact is, this plant consider as a 'mother's best friend' in country like Philippine because of its utilization to increase woman's milk production [12,13].

Plant and its products are rich sources of a phytochemicals and have been found to possess a variety of biological activities including antioxidant potential [8,14]. *M. oleifera* contains various phytochemicals, such as carotenoids, vitamins, minerals, amino acids, sterols, glycosides, alkaloids, flavonoids and phenolics [3,12,15]. The antioxidants could attenuate oxidative damage of a tissue indirectly (enhancing natural defenses of cell) or by indirectly (by scavenging the free radical species) and delay the onset or slow the progression of various chronic diseases. Leaves of this plant are known to have various biological activities, including hypocholesterolemic agent [16], regulation of thyroid hormone status [17], anti-diabetic agent [18], gastric ulcers [19], anti-tumor agent [20] and hypotensive agent [21]. Many reports showed that leaves, flowers, roots, gums, fruits and seeds are extensively used for treating inflammation [22], cardiovascular action [23], liver disease [24] and hematological, hepatic and renal function [25]. In many regions of Africa, it is widely consumed for self-medication by patients affected by diabetes, hypertension, or HIV/AIDS [26-28].

Chumark et al. [29] reported that feeding water extract of *Moringa oleifera* leaves significantly reduced the formation of atherosclerotic plaque in internal carotid arteries, along with levels of cholesterol and triglycerides in Male New Zealand white rabbits fed with high cholesterol diet. *Moringa* fruit also has been found to lower the serum cholesterol, phospholipids, triglycerides, low density lipoprotein, very low density lipoprotein cholesterol to phospholipid ratio, atherogenic index lipid and reduced the lipid profile of liver, heart and aorta in hypercholesteremic rabbits and increased the excretion of fecal cholesterol [30]. Jaiswal et al. [31] demonstrated that aqueous extract of *M. oleifera* leaves reduces the blood glucose level in normal rats and normalizes the high blood glucose levels in sub, mild and severely diabetic rats. It also improves glucose tolerance in normal, sub and mild diabetic male albino Wistar rats than Glipizide (it is a reference drug in diabetic research for positive control). Kumar et al. [4] examined the hypoglycemic effect of *M. oleifera* leaf dietary consumption over a 40-

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day period in T2DM patient, 30-60 years of age of men, not on anti-hyperglycemic medication. The experimental groups received a daily dose of 8 g *M. oleifera* leaf powder. FPG and PPPG at the end of the protocol were compared to base line levels and found that they were significantly reduced in the experimental group (FPG: -28%, $P < 0.01$, PPPG: -26%, $P < 0.05$). Bharali et al. [32] reported that ingestion of *M. oleifera* extracts significantly reduce the skin papillomas in mouse model. Among the isothiocyanates, naturally occurring in leave 4-[(4'-O-acetyl- α -i-rhamnosyloxy) benzyl] [2], significantly inhibited tumor-promoter induced Epstein-Barr virus activation, suggesting that the isothiocyanate group is a critical structural factor for activity [20].

Prabhu et al. [33] demonstrated that Larvicidal activity of *M. oleifera* plant seed extract exhibited in the first to fourth instar larvae of the *Anopheles stephensi*. Doughari et al. [34] demonstrated that the antibacterial activity of the ethanol extracts of the Moringa showed 8 mm zone of inhibition at 10 mg/ml against *Salmonella typhi*. Mehta et al. [30] reported that the juice from the stem bark of Moringa showed antibacterial effect against *Staphylococcus aureus*. Nikkon et al. [35] reported that the aglycone of deoxy-niazimicine (N-benzyl, S-ethyl thioformate) isolated from the chloroform fraction of an ethanol extract of the Moringa root bark showed the antibacterial and antifungal activities. Saadabi and Abu Zaid [36] reported that aqueous extract of Moringa was inhibitory against pathogenic bacteria, including *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, and *Pseudomonas aeruginosa* in dose dependent manner. Phytochemicals have been of enormous interest as a source of natural antioxidants used for health benefits, food preservation, food flavoring and cosmetics, as they are safer than synthetics. Currently there has been an increased interest worldwide to identify antioxidant compounds from plant sources like *Moringa oleifera* which are pharmacologically potent and have small or no side effects for use in protective medicine in human/animal health and the food industry.

Currently, *Moringa oleifera* has been shown that it could potentially serve as a natural alternative to many medical conditions associated with chronic infections, antimicrobial resistance and other public health related issues. I think it would be prudent from both the food and pharmaceutical industry to continue to explore ways to discover novel bioactive compounds and continue to forge a relationship with our government regulatory agencies to help expedite the development of new drugs.

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