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Drumstick tree: A miracle for well-being and Socio-pecuniary diverse therapeutic applicability

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A B S T R A C T

This review focuses on the detailed phytochemical composition, therapeutic applicability, along with pharmacological assets of different parts of this multipurpose tree. Reported studies in experimental animals and humans, although limited in number and variable in design, seem rigorously concordant in their support of therapeutic potential. Of importance is that various parts of this plant viz. the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine, particularly in South Asia. Of utmost importance is its ability to aid in the cure of those diseases without any side effects or allergic reactions commonly experienced with western medicines. Also, since dietary treatment is one of the core programs in treating systemic conditions like hypertension, diabetes, anaemia, kidney conditions & Blood Pressure, some forms of cancer, diabetes, AIDS, arthritis, rheumatism, asthma, ulcer, prostrate problems, erectile dysfunction, sexual virility, cholesterol control, syphilis and many others. Moringa combined the rare dual role as the ideal meal supplement and ideal medicine. Global industrialization and the increasing demand for environmental friendly products make moringa have great potential as a source of pharmaceuticals, dyes, biofuel, human food, animal and fish feed, and water purification products. Phytochemical analyses have shown that its leaves are particularly rich in K, Ca, P, Fe, vitamins A and D, essential amino acids, as well as such known antioxidants such as β-carotene, vitamin C, and flavonoids. Further research considering relevance to explore the potential of *M oleifera's* various parts has to be emphasized. This has prompted scientific research by the WHO, universities and organizations who have verified and concluded on most of its diverse medicinal properties on an on-going basis.

Keywords: ROS, CVD, SOD, GTH, Diabetes, Water purification, Biodiesel, Quercetin-3-*O*-β-d-glucoside, Chlorogenic acid, Phenolic acids, Free radicals, Oxidative stress, Pathogenesis

A R T I C L E I N F O

CONTENTS

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1. Introduction

From time immemorial and historical perspective, it's evident that affluent stockroom of traditional therapeutic lashing medication of drum stick tree is well documented and enthralling in ancient literature. *Moringa oleifera*, the Tree of Life or a Miracle Tree, but rather than this being in reference to its potential medicinal usage this is actually referring to how It's a very valuable food crop (It's drought resistant, grows very fast, and is highly nutritive) and even beyond food it serves many benefits in third world countries such as having an ability to be used for some crafts (due to being a tree) and cleaning water. For usage as a supplement, *moringa oleifera* is recommended mostly as being a highly nutritious antioxidant. All parts of the Moringa tree are edible and have long been consumed by humans. According to Fuglie[1] the many uses for Moringa include: alley cropping (biomass production), animal forage (leaves and treated seed-cake), biogas domestic cleaning agent blue dye (wood), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey- and sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), water purification[67-69] (powdered seeds). Moringa seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity.

M olifera is one of the most tropical trees. The relative ease with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water after being planted makes its production and management easy. Introduction of this plant into a farm, which has a biodiverse environment, can be beneficial for both the owner of the farm and the surrounding eco-system. Distinction of cultivators has not yet been formally carried out. *M oleifera* was well known to the ancient world, but only recently has it been rediscovered as a multipurpose tree with a tremendous multiplicity of potent applicability[1-3]. *Moringa oleifera* Lam. is the most "underutilized" multipurpose tropical crop. The leaves, tender pods and seeds could serve as a valuable source of nutrients for all age groups. The leaves, tender pods and seeds are sources of vitamins, minerals and proteins. The leaves and branches can be used as feed for livestock and fish. Due to the high nutrient content of the leaves, moringa can be incorporated into the mulching system. Moringa has demonstrated its effectiveness in the management and/or treatments of various ailments taking place in physiological systems of body. Due to its multidimentional benefits, *Moringa oleifera* is called the miracle tree, the tree of life, mother's best friend, etc.

It has been used in salads, for fine machine lubrication, and in the manufacture of perfume and hair care and health products[2]. In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water4-6 but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries[4]. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern.

The Moringa tree gained popularity because of its high uses in traditional medicine originally by the Indians. Preparations (e.g. extracts, decoctions, poultices, creams, oils, emollients, salves, powders, porridges) are not quite so well known[4]. Presently, numerous scientific investigations have confirmed the effectiveness of these traditional remedies. Also based on research the plant is very nutritious, earning it the WHO candidate in the fight against malnutrition. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, β-carotene, amino acids and various phenolics. The Moringa plant provides a rich and rare combination of

zeatin, quercetin, β-sitosterol, caffeoylquinic acid and kaempferol. In addition to its compelling water purifying powers and high nutritional value.

The *M oleifera* pod is often used to prepare a variety of sambars and is also fried. In other parts of India, especially West Bengal, and also in a neighboring country like Bangladesh, it's enjoyed very much. It's made into a variety of curry dishes by mixing with coconut, poppy seeds and mustard or boiled until the drumsticks are semi-soft and consumed directly without any extra processing or cooking. It has find utility in curries, sambars, kormmas, and dals, although it's used to add flavor to cutlets, etc. In MS, the pods are used in sweets and curries called Aamatee. Tender drumstick leaves, finally chopped, are used to garnish veggie dishes, dals, sambars, salads, etc. also, it has gained popularity to be used as coriander, as these leaves have high therapeutic significance. Its flowers, in some regions, are gathered and cleansed to be cooked with basan to make pakoras. It's preserved by canning and exported world wider.

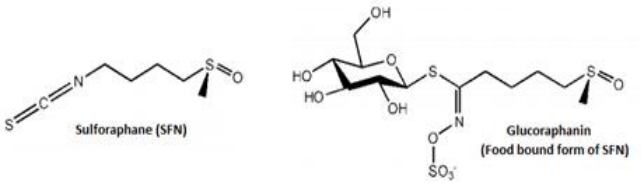
The dry seed suspension is a known natural coagulant and coagulant aid with antibacterial activity. Dry moringa seeds can be used in place of alum to treat turbid water and reduce bacteria in drinking water Geographically, many of developing countries are located in the tropical and sub-tropical regions of the world where *M. oleifera* grows and is cultivated. If validated by medical science, dietary consumption of this plant could be advocated in these and other countries as an inexpensive prophylactic strategy against DM, and chronic dyslipidemia a risk factor for CVD. Chronic hyperglycemia is an indicator of DM and chronic dyslipidemia a risk factor for CVD. These metabolic disorders are global epidemics[13].

2. Nutritional assessment of the raw Moringa leaf/100g

Moringa is traditionally part of the staple food diet of many countries like India, Thailand, Cambodia, Sri Lanka, etc. and even the Hausas in northern Nigeria. It's estimated to have more than 92 verifiable cell-ready nutrients, 46 types of antioxidants and 36 anti-inflammatories. Energy 64kCal (270kJ); Carbohydrates 8.28 g; Dietary Fiber 2.0 g; Fat 1.40 g; Protein 9.40 g; Water 78.66 g; Vitamin A equiv 378 ug (47%); Thiamine (Vit B1) 0.257 mg (22%; Riboflavin; Vit B2) 0.660 mg (55%); Niacin (Vit B3) 2.220 (15%); Panthothenic acid (Vit B5) 0.125 mg (3%); Vitamin B6 1.200 mg (92%); Folate (Vit B9) 40 mg (10%); Vit c 51.7 mg (62%); Ca 185 mg (19%); Fe 4.00 mg (31%); Mg147 mg (41%); Mn 0.36 mg (17%); P112 mg (16%); P 337 mg (7%); Na 9 mg (1%); Zn 0.6 mg (6%) [Source: USDA Nutrient Database] Most of these foods are even more expensive and mostly seasonal while Moringa leaves are available year round. Since dried Moringa leaves retain their nutrient content, It's possible and convenient to convert them into leaf powder which is easy to make, store and use. Moringa has the unique advantage of being somewhat tasteless so it makes excellent nutritional supplement that can be added to any dish or taken on its own. This is why Moringa is being advocated as "natural nutrition for the tropics." The great majority of multivitamins available today are synthesized and chemically formulated so most of them are not easily absorbed by the body while Moringa is a natural whole food source for vitamins, minerals, proteins, antioxidants and other important components that the body relies upon to stay healthy.

Regular intake of Moringa will give benefits of increased energy, greater alertness, better endurance, increased focus, mental clarity, strong immune system, etc. also rare for a plant source, Moringa leaves contain all the essential Amino Acids (usually found only in animal products like eggs) in good proportion including argenine and histidine which are especially important for infants. Hence, Moringa leaf is a food source for infants, children, pregnant women and everybody. The reason for the increased potency in living models is not known (although It's possible that it can induce genetic transcription similar to SFN. Since the bioactive compounds are similar in structure), but the antioxidant properties seem to underlie the vast majority of benefits associated with this supplement. There are also antiinflammatory effects that, while less studies, seem to be quite effective; one of the bioactives, RBITC, is effective in

suppressing macrophage activation in the nanomolar range which is worth some future research into. Beyond that, there does appear to be a nice anti-diabetic effect that has gone some very preliminary human testing which suggests that this plant may benefit pancreatic function and reduce blood glucose secondary to that.

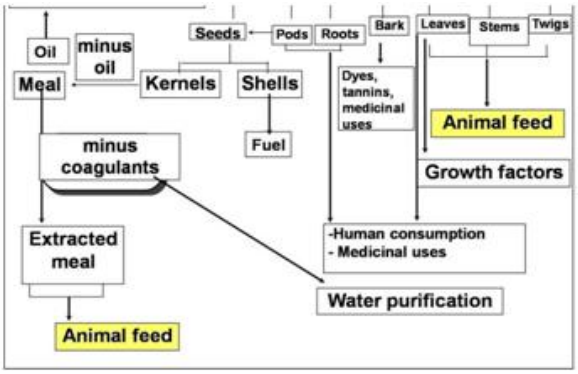


Now, despite the plant being referred to as 'nontoxic' this does not appear to be the case. While supplemental dosages listed below appear to be safe from all tested toxicity a relatively small increase (3-4x the recommended does) is known to cause genotoxic damage and may promote cancer formation whereas doses higher than that cause overt organ damage (mostly liver and kidneys).

3. Phytochemical aspects of *M. Olifera*

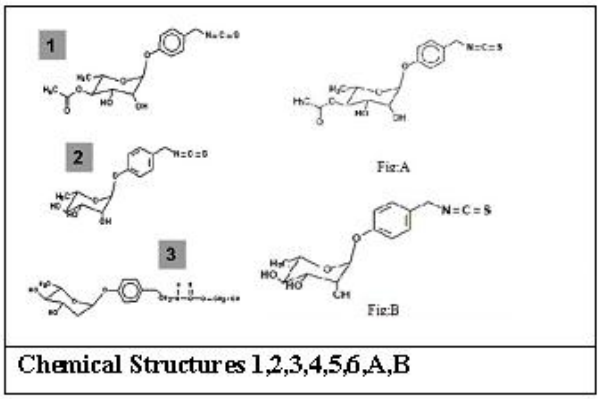
Because of the chemical complexity of the *M. oleifera*, apparent therapeutic effects could be due to the combined actions of various bioactive components found in the plant, including trace metal ions, vitamins, alkaloids, carotenoids, polyphenols, fats, carbohydrates, and proteins. Some compounds may collectively affect broad aspects of physiology, such as nutriment absorption and processing, redox state, or immunity. *Moringa oleifera* leaves contain phytosterols such as β-sitosterol[15]. These compounds can reduce intestinal uptake of dietary cholesterol[16]. They could partly account for the decrease of plasma cholesterol and the increase of fecal cholesterol observed in rodents treated with *M. oleifera* leaves[17-18] *M. oleifera* leaf powder also contain about 12% (w/w) fibers[19]. Dietary fibers reduce gastric emptying[20]. They may partly explain the greater stomach content, the improved OGTT response in treated GK diabetic rats, as well as the progressive improvement of PPBG levels in treated T2DM patients[22].

Graphic representation of *M oleifera* Lim. Applicability



The viability and functionality of a cell partly depends on a favorable redox state, i.e., on its ability to prevent excessive oxidation of its macromolecules, including DNA proteins, and lipids[23]. ROS and free radicals are the major mediators of the oxidative process. Cellular inability to reduce ROS leads to oxidative stress. All cells are variably capable of endogenous self-protection against this stress through the actions of enzymes such as catalase, superoxide dismutase, and glutathione peroxidase, as well as through reducing molecules such as glutathione. Nutritional antioxidants such as vitamins A, C, and E provide additional protection from the stress[24]. Oxidative stress is widely accepted as a major contributing factor in the pathogenesis of CVD and diabetes[25,26]. A recurring explanation for the therapeutic actions of *M. oleifera* medication is the relatively high antioxidant activity of its leaves, flowers, and seeds[27-36]. Glucosinolates are characterized by β-thioglucoside *N*-hydroxysulfate motif. In *M. oleifera* leaves, most phytochemicals of this class carry a benzyl-glycoside group linked to the single carbon of the motif. The most abundant of them is 4-*O*-(α-l-rhamnopyranosyl-oxy)-benzyl glucosinolate, otherwise known as glucomoringin[35]. Enzymatic hydrolysis of the glucosinolate motif of members of this class leads to the formation of corresponding isothiocyanates, thiocyanates, or nitriles. Several of these by-products have been shown to possess antihypertensive properties.

Flavonoids and phenolic acids are collectively referred to phenolic compounds. The structural skeleton of flavonoids is made of two aromatic rings joined by a 3-C link; that of the sub-class of flavonols is 3-hydroxy-2-phenylchromen-4-one, Quercetin and kaempferol, in their as 3′-*O*-glycoside forms, are the predominant flavonols in *M. oleifera* leaves. The sugar moieties include, among others, rhamnoglycosyl (rutinosides), glucosyl (glucosides), 6′ malonyglucosyl, and 2′-galloylrutinoside groups. Biologically, flavonoids are best known for their antioxidant properties, but their metabolic pathways of activity remain to be fully elucidated[43]. Phenolic acids have benzoic acid and cinnamic acid as backbones, with one or several (-OH) hydroxyl groups. Chlorogenic acid, which is an ester of dihydrocinnamic acid (caffeic acid) and quinic acid, is a major phenolic acid in *M. oleifera* leaves. The flavonol quercetin is found at concentrations as high as 100 mg/100 g of dried *M. oleifera* leaves predominantly as quercetin-3-*O*-β-d-glucoside also known as isoquercitrin or isotrifolin.



Quercetin is a potent antioxidant45 with multiple therapeutic properties (Bischoff, 2008). It can reduce

hyperlipidemia and atherosclerosis in HCD or HFD rabbits 46,-48. It has shown anti-dyslipidemic, hypotensive, and anti-diabetic effects in the obese Zucker rat model of metabolic syndrome. It can protect insulin-producing pancreatic β cells from STZ-induced oxidative stress and apoptosis in rats. Its hypotensive effect has been confirmed in a randomized, double-blind placebo-controlled, human study. Chlorogenic acid can beneficially affect glucose metabolism. It has been shown to inhibit glucose-6-phosphate translocase in rat liver, reducing hepatic gluconeogenesis and glycogenolysis. It was found to lower PPBG in obese Zucker rats. In OGTT experiments performed on rats or humans, it reduced the glycemic response in both species; in rodents, it also reduced the glucose AUC. Its anti-dyslipidemic properties are more evident as its dietary supplementation has been shown to significantly reduce plasma TC and TG in obese Zucker rats or HFD mice and to reverse STZ -induced dyslipidemia in diabetic rats[29-31].

The alkaloid moringinine was initially purified from M. oleifera bark and later chemically identified as benzylamine. It's also present in leaves. This substance was suspected to mediate the hypoglycemic effect of the plant. An early study showed that Wistar rats provided with drinking water containing 2.9 g/L of benzylamine for 7 weeks exhibited a reduced hyperglycemic response in IPGTT suggesting improved glucose tolerance[62]. More recently, the effect was further explored using HFD -fed, insulin-resistant C57BL/6 mice taking an estimated daily dose 386 mg/kg-body weight in drinking water for 17 weeks. Compared to untreated controls, these mice gained less weight, had reduced FPG and PTG and were more glucose tolerant[27].

Niaziminin is a mustard oil glycoside initially isolated (along with other glycosides such as niazinin and niazimicin) from ethanolic extracts of **M. oleifera** leaves, based on their hypotensive properties on Wistar rats. At 1 mg and 3 mg/kg-body weight, these compounds caused a 16–22 and a 40–65% fall of MABP. Other active isothiocyanate glycosides and thiocarbamates were isolated from the plant using the same bioassay. This compound was isolated from M. oleifera roots and structurally identified as N-benzoyl phenylalanyl phenyl alinol acetate. At 25 μM, this unusual dipeptide derivative inhibited by nearly 90% the secretion TNFα and IL-2 from lipopolysaccharide-stimulated peripheral blood lymphocytes in culture. It had no effect on IL-6 secretion. This inhibitory activity may contribute to the anti-inflammatory properties of the plant[31]. An examination of the phytochemicals of Moringa species affords the opportunity to examine a range of fairly unique compounds. In particular, this plant family is rich in compounds containing the simple sugar, rhamnose, and it's rich in a fairly unique group of compounds called glucosinolates and isothiocyanates. For example, specific components of Moringa preparations that have been reported to have hypotensive, anticancer, and antibacterial activity include 4-(4'-O-acetyl-a-L-rhamnopyrano syloxy) benzyl isothiocyanate**,** m4-(a-L-rhamnopyranosyloxy) benzyl isothiocyanate**,** niazimicin, pterygospermin**,** benzyl isothiocyanate**,** and 4-(a-L-rhamnopyranosyloxy)benzyl glucosinolate**.** While these compounds are relatively unique to the Moringa family, it's also rich in a number of vitamins and minerals as well as other more commonly recognized phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A). These attributes are all discussed extensively by Lowell and others, and will be the subject of a future review in this series.

Health benefits of moringa

a. Moringa plant possesses unique nutritional qualities that hold promise to millions of impoverished communities around the world who in need of nutritional supplements like protein, minerals, and vitamins.
b. Moringa greens (leaves) are an excellent source of protein which is a unique feature for any herbs and leafy-greens in the entire plant kingdom. 100 g of fresh raw leaves carry 9.8 g of protein or about 17.5% of daily-required levels. Dry, powdered leaves indeed are a much-concentrated source of several quality amino acids.
c. Fresh pods and seeds are a good source of oleic acid, a health-benefiting monounsaturated fat. Moringa, as a high-quality oilseed crop, can be grown alternatively to improve nutrition levels of populations in many drought-prone regions of Africa and Asia.
d. Fresh leaves and growing tips of moringa are the richest source of vitamin A. 100 g of fresh leaves carry 7564 IU or 252% of daily-required levels of vitamin A! Vitamin A is one of the fat-soluble anti-oxidant offering several benefits, including mucus membrane repair, maintenance of skin integrity, vision, and immunity.
e. Fresh moringa pods and leaves are an excellent sources of vitamin-C. 100 g of pods contain 145 µg or 235% of daily-required levels of vitamin-C. 100 g of greens provide 51.7 µg or 86% of daily-recommended intake values of this vitamin. Research studies have shown that consumption of fruits/vegetables rich in vitamin C helps the body develop immunity against infectious agents, and scavenge harmful oxygen-free radicals from the body.
f. The greens as well as pods also contain good amounts of many vital B-complex vitamins such as folates,vitamin-B6 (pyridoxine), thiamin (vitamin B-1), riboflavin, pantothenic acid, and niacin. Much of these vitamin functions as co-enzymes in carbohydrate, protein, and fat metabolism.
g. Furthermore, its leaves are one of the finest sources of minerals like Ca, Fe, Cu, Mn, Zn, Se & Mg. Fe alleviates anemia. Ca s required for bone mineralization. Zn plays a vital role in hair-growth, spermatogenesis, and skin health.

Moringa: A Source of II age bracket Biodiesel

With years of continuing research, experiments and trials has provided an adage to find and develop 2nd generation

biodiesel feedstock with low cost input technology. *Moringa oleifera* is a very fast growing tree; it commonly reaches four meters in height just 10 months after the seed is planted and can bear fruit within its first year. Its seeds are triangular in cross-section (30 to 50 cm long) and legume-like in appearance. These seeds have oil rich black and winged seeds, which can be crushed to produce biodiesel. Moringa could yield +3 ton oil/ ha and that it could be used for food in times of shortages. The seeds contain 30%t o 40% oil that is high in oleic acid. The meal yields about 61% protein. Biodiesel made from Moringa has better oxidative stability than biodiesel made with most other feedstock. The crop's multiple dimensions would make it attractive to farmers worldwide. Other than biodiesel, the pods can also produce highly nutritious edible seeds. Their pods are harvested, meaning that the trees keep on growing, using water and reducing the high water table whilst sequestrating carbon. The *Moringa oleifera* trees must be regarded as a sure source of 2nd Generation Biodiesel. The *Moringa oleifera* tree that has enough credentials: a higher recovery and quality of oil than other crops, no direct competition with food crops as It's a edible source of fuel, and no direct competition with existing farmland as can be grown for both purpose same time[32-33].


4. Conclusion

A large number of reports on the nutritional qualities of Moringa now exist in both the scientific and the popular literature. This fast growing tree now well now for its employability in human nutrition, dye, fodder, and water decontamination as it bears an imposing assortment for day to day welfare of wellbeing and socioeconomic comfort. Extensive field reports and ecological studies forming part of a rich traditional medicine history, claim efficacy of leaf, seed, root, bark, and flowers against a variety of dermal and internal infections. Moringa seed contain oil that can be used for various industrial purposes and as vegetable oil for human consumption or as biofuel. Though apparently native only to restricted areas in the southern foothills of the Himalayas, *M. oleifera* is cultivated in all the countries of the tropics. Outstanding oil is derived from the seeds, which is used for cooking and lubrication of delicate mechanisms. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce. We can clearly affirm the superiority of Moringa over the other foods. As it was found that Moringa leaves contain more Vitamin A than carrots, more Ca than milk, more Fe than spinach, more Vitamin C than oranges, and more K than bananas," and that the protein quality of Moringa leaves rivals that of milk and eggs. Clearly much more research is justified, but just as clearly this will be a very fruitful field of endeavor for both basic and applied researchers over the next decade. Moringa preparations (e.g. extracts, decoctions, poultices, creams, oils, emollients, salves, powders, porridges) are not quite so well known. A plethora of traditional medicine references attest to its curative power, and scientific validation of these popular uses is developing to support at least some of the claims. Moringa preparations have been cited in the scientific literature as having antibiotic, antitrypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypocholesterolemic, and hypoglycemic activities, as well as having considerable efficacy in water purification by flocculation, sedimentation, antibiosis and even reduction of Schistosome cercariae titer. *M. oleifera* is also of interest because of its production of compounds with antibiotic activity such as the glucosinolate 4 alpha-L-rhamnosyloxy benzyl isothiocyanate. Other research has focused on the use of *M. oleifera* seeds and fruits in water purification. Of importance is that all parts of Moringa are edible and also effective when used for treating various diseases. Any researches continue to be conducted on further establishment of Moringa as a potent medical solution and many are directed towards the acceptance and commercialization of Moringa bio active components. Meeting all bodies nutritional requirements will naturally curb junk food cravings and supply with the energy needed to maintain a healthy & active lifestyle.

5. Abbreviations

CVD (Cardio Vascular Disease); USDA (United States Dietary Association); , RBITC (*rhodamine B isothiocyanate)*; SFN (Sulphorafane); OGTT (Oral Glucose Tolerance Test); GK (Goto-Kakizaki) PPBG (Post-Prandial Blood Glucose) ; T2DM (Type-2 Diabetes Mellitus); GK (Goto-Kakizaki); HCD (High-Cholesterol Diet) or HFD (High-Fat Diet) STZ (Streptozotocin); MABP (Mean Arterial Blood Pressure); AUC (Area Under the Curve); DNA (Deoxyribose Nucleic Acid); ROS (Regenerative Oxygen Species); PTG ((Plasma Triglyceride); FBG (Fasting Blood Glucose); AIDS (Acquired Immuno Deficiency Syndrome)

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