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Potential of Underutilized Drumstick (*Moringa Oleifera)*

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Abstract

Underutilized green leafy vegetables (GLV) are found in numerous agricultural ecosystems and often survive mainly in marginal areas. Yet a large number of GLV that are now overlooked have the potential to play a much more important role in sustaining livelihoods and enhancing environmental health. India, being blessed with a variety of naturalsurroundings and varying climates and seasons, has a number of edible GLV some of which are locally grown and utilized. GLV are rich sources of micronutrients such as β-carotene, ascorbic acid, riboflavin and folic acid, iron,calcium and phosphorous. GLV are also recognized for their characteristic colour, flavor and therapeutic value. Some of the underutilized leafy vegetables are amaranth, drumstick, beet greens rich in micronutrients. Drumstick has a high nutrient density and is rich in many essential micronutrients and vitamins as well as antioxidants and bioavailable iron. It excelled among 120 species of Asian traditional vegetables tested for their content of micronutrients and phytochemicals, antioxidant activity and traditional knowledge of their medicinal uses. Moreover, it is easy to grow, has excellent processing properties, and good palatability.

Keywords: Drumstick, Underutilized

Drumstick (*Moringa oleifera)*

Morphology and Bioactive compounds

Lako *et al* (2007) reported that drumstick leaves have a high total antioxidant capacity (260 mg/100 g) and are rich in total polyphenol content (260 mg/100 g), quercetin (100 mg/100 g), kaempferol (34 mg/100 g) and β-carotene (34 mg/100 g).

Niaziridin is a bioenhancer for drugs and nutrients. Shanker *et al* (2007) identified Niaziridin (0.015% and 0.039%) and niazirin (0.038% and 0.033%) present in leaves and pods, respectively. Relatively higher amount of niazirin was present in leaves in comparisons to the pods while niaziridin content was about three times higher in the pods than the leaves. Niaziridin enhances the bioactivity of commonly used antibiotics such as rifampicin, tetracycline and ampicillin against gram (+) and (-) bacteria and also facilitate the absorption of drugs, vitamins and nutrients through the gastro-intestinal membrane thus increasing their bio-availability.

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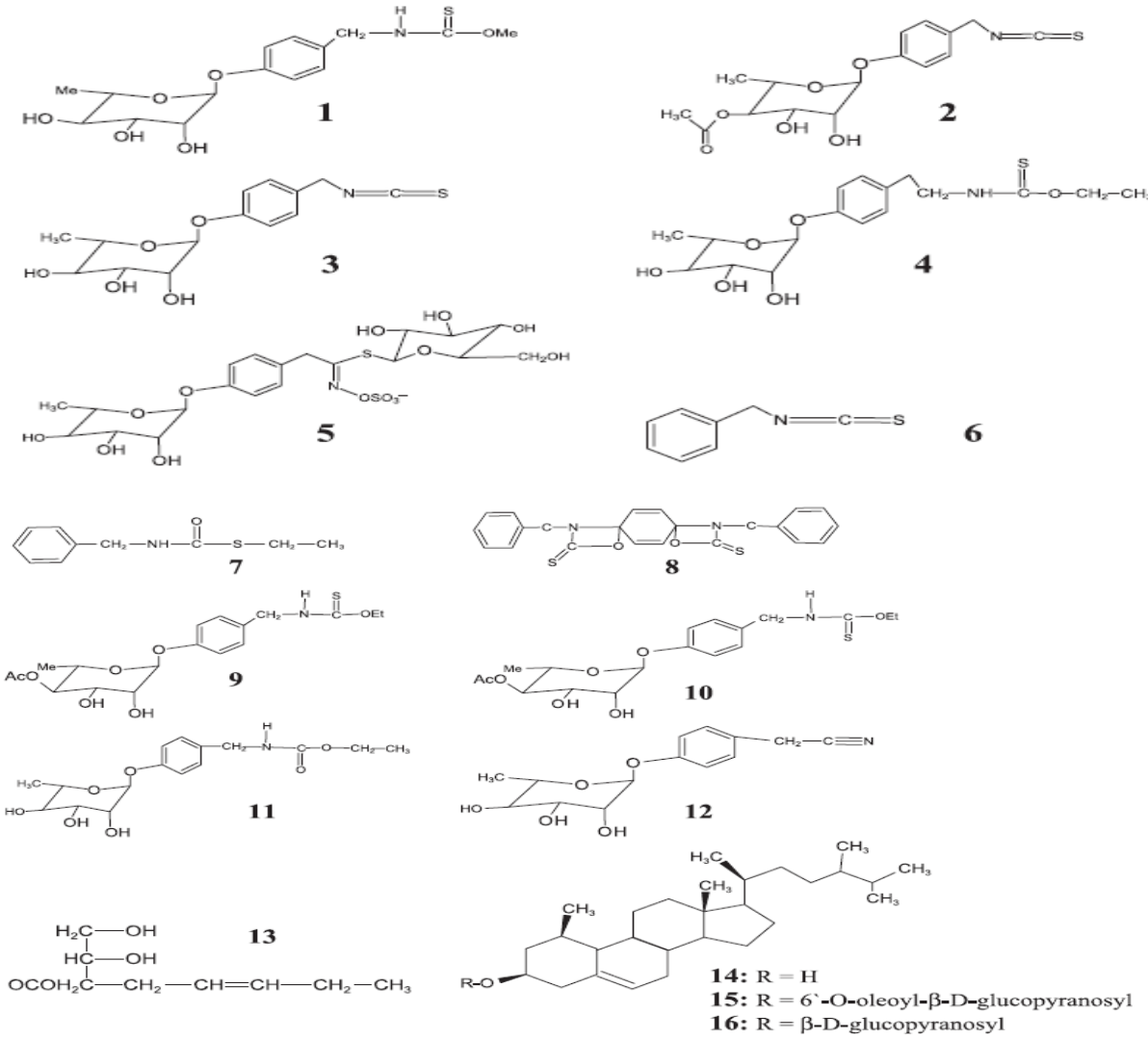

Fig. 1 Structures of selected phytochemicals from Moringa: niazinin A **[1]**, 4-(4′-O-acetyl-α-L-rhamnopyranosyloxy)benzyl isothiocyanate **[2]**, 4-(-L-rhamnopyranosyloxy)benzyl isothiocyanate **[3]**, niazimicin **[4]**, 4-(α-L-rhamnopyranosyloxy)benzyl glucosinolate **[5]**, benzyl isothiocyanate **[6]**, aglycon of deoxy-niazimicine (N-benzyl, S-ethylthioformate) **[7]**, pterygospermin **[8]**, niaziminin **[9 + 10]**, O-ethyl-4-(α-L-rhamnosyloxy)benzyl carbamate **[11]**, niazirin **[12]**, glycerol-1-(9-octadecanoate) **[13]**, β-sitosterol **[14]**, 3-O-(6′-O-oleoyl- β-D-glucopyranosyl)-β-sitosterol **[15]**, β-sitosterol-3-O-β-D-glucopyranoside **[16]** (Anwar *et al* 2007).

In Asia, the flowers of drumstick are mixed together with other foods since they are rich in $Ca^{2+,}$ K^{+}, waxes, alkaloids, quercetin and kaempferol. Quercetin and kaempferol are flavonoids, compounds with phenolic hydroxyl groups with antioxidant action that have potential therapeutic uses (Ferreira *et al* 2008).

Chumark *et al* (2008) found that in scavenging 1,1-diphenyl-2-picrylhydrazyl radicals the extract of drumstick leaves and Trolox (a water-soluble derivative of vitamin E)

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had IC50 of 78.15±0.92 and 2.14±0.12g/ml, respectively. The extract significantly ($P < 0.05$) prolonged the lag-time of conjugated diene formation and inhibited 1,1-diphenyl-2-picrylhydrazyl radicals formation in both in vitro and ex vivo experiments in a dose-dependent manner. In hypercholesterol-fed rabbits, at 12 weeks of treatment, it significantly ($P < 0.05$) lowered the cholesterol levels and reduced the atherosclerotic plaque formation to about 50 and 86%, respectively. The results indicate that plant possesses antioxidant, hypolipidaemic and antiatherosclerotic activities and has therapeutic potential for the prevention of cardiovascular diseases.

Amaranth leaves, drumstick leaves, strawberries, spinach and red wine are rich in antioxidant phenolic compounds, which can increase the serum antioxidant capacity in humans (Ali *et al* 2008, Verma *et al* 2009).

Drumstick leaves contain cytokinins in the form of zeatin, other phytochemicals such as beta-sitosterol, caffeoylquinic acids, kaempferol, quercetin, octacosanoic acid, moringine, moringinine, indole acetic acid, indole acetonitrile. Leaves also contribute great values of calcium, magnesium, phosphorous, potassium, sulfur, zinc, selenium, vitamin E, riboflavin, niacin, choline, alanine, aspartic acid, glutamic acid, histidine, isoleucine, leucine, lysine, methionine, proline, serine, tryptophan, tyrosine, valine and chlorophyll (Andrews and Andrews 2009).

Antioxidant properties of the drumstick leaf extracts were tested in two stages of maturity using standard in vitro models. The successive aqueous extract of drumstick exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The free radical scavenging effect of drumstick leaf extract was comparable with that of the reference antioxidants. Study suggested that the extracts of drumstick both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage (Sreelatha and Padma 2009).

Krishnaiah *et al* (2009) reported that leaves of drumstick contains percentage of alkaloids 0.36±0.07, Tannins 9.2±0.26, saponins 2.3±0.04, flavonoids 0.51±0.18, phenols 0.08±0.17. The leaves and drumstick pods are used for diabetes, hypoglycemia and hypertension treatment. The presence of terpenoids and saponins explains its use in diabetes treatment, because both constituents are ethno pharmacologically used to treat diabetes and hyperglycemia, a disorder often associated with diabetes.

Table 1. Phytochemical constituents of *Moringa oleifera* from different part (Patel *et al* 2010)

Parts	Phytochemical constituents
Roots	4-(a-L-rhamnopyranosyloxy)-benzylglucosinolate and benzylglucosinolate
Stem	4-hydroxymellein, vanillin, ß-sitosterone, octacosanic acid and ß-sitosterol
Bark	4-(a-L-rhamnopyranosyloxy)-benzylglucosinolate
Whole gum exudates	L-arabinose, D-galactose, D-glucuronic acid, L-rhamnose, D-mannose, D-xylose and leucoanthocyanin

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Leaves	Glycoside niazirin, niazirinin and three mustard oil glycosides, 4-[4'-O-acetyl- a -L-rhamnosyloxy) benzyl] isothiocyanate, niaziminin A and B
Mature flowers	D-mannose, D-glucose, protein, ascorbic acid, polysaccharide
Whole pods	Nitriles, isothiocyanate, thiocarbanates, 0-[2'-hydroxy-3'-(2'-heptenyloxy)]-propylundecanoate, 0-ethyl-4-[(a -1 rhamnosyloxy)-benzyl] carbamate, methyl-p-hydroxybenzoate and ß-sitosterol
Mature seeds	Crude protein, Crude fat, carbohydrate, methionine, cysteine, 4-(a-L-rhamnopyranosyloxy)-benzylglucosinolate, benzylglucosinolate, moringyne, mono-palmitic and di-oleic triglyceride
Seed oil	Vitamin A, beta carotene, precursor of Vitamin A

Moringa oleifera is indigenous to south Asia, where it grows in the Himalayan foothills from northeastern Pakistan to northern West Bengal, India. It has been introduced and become naturalized in other parts of India, Pakistan, Afghanistan, Bangladesh, Sri Lanka, Southeast Asia, West Asia, east and west Africa, southern Florida, throughout the West Indies, and from Mexico to Peru, Paraguay, and Brazil (Mahmood *et al* 2010).

The drumstick plant is a perennial, evergreen tree that grows up to 20 ft (6.1 m) tall, with a straight trunk with corky, whitish bark. The tree has tuberous taproot and brittle stem is with corky bark. The leaves are pale green, compound, tripinnate, 30-60 cm (11.8 to 23.6 in) in length, with many small leaflets. The lateral leaflets are elliptic in shape while the terminal one is obovate and slightly larger than the lateral ones. The fruit pods are pendulous, green turning greenish brown, triangular and split lengthwise into 3 parts when dry. The pods are 1 to 4 ft (30-120 cm) long and 1.8 cm (0.7 in) wide and tapering at both ends. The pods contain about 10 to 20 seeds embedded in the fleshy pith (Patel *et al* 2010).

Table 2 Phytochemicals in leaves of *Moringa oleifera* (Kasolo *et al* 2010)

Phytochemical	Ether extract	Ethanol extract	Water extract
Gallic tannins	+	+	++
Catechol tennins	+	-	++
Coumarins	-	-	-
Steroids and triterpenoids	+++	++	++
Flavonoids	++	++	++
Saponins	+	+	++
Anthraquinones	+	++	+++
Alkaloids	+	-	++
Reducing sugars	-	++	++

Key – Not detected, + present in low concentration, ++ present in moderate concentration, +++ present in high concentration

Sharma *et al* (2010) reported that the maximum content of soluble sugar (57.2±0.53 mg/gdw) and phenols (41.0±0.33 mg/gDW) were found in stem part, starch (42.0±0.60 mg/gDW) and lipid (46.0±0.05 mg/gDW) in leaf part and proteins in pods (41.0±0.30 mg/gDW) of drumstick.

Drumstick leaves also contain alkaloids which are nitrogen-containing naturally occurring compound, commonly found to have antimicrobial properties due to their ability to intercalate with DNA of the microorganisms. The presence of glucosinolates and hypotensive thiocarbamite glycosides in drumstick, contributes to the use of the plants in hypertension. On the other hand, they are also reported to modify tumorigensis, able to inhibit carbohydrate-mediated tumor growth, induced a stress response and apoptosis in human breast cancer cells. Anthraquinones (9, 10-dioxoanthracene) which are a group of naturally occurring phenolic compounds are found in drumstick leaves and tend to have laxative effects. Terpenoids and steroids present in leaves are described as being active against bacteria such as *Staphylococcus aureus*, capable of preventing cancer having anti-carcinogenic effects (Kasolo *et al* 2010).

Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Three non-governmental organizations in particular—Trees for Life, Church World Service and Educational Concerns for Hunger Organization—have advocated Moringa as "natural nutrition for the tropics." 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.

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