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## Chemical Constituents of Murunga Tree

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It is obvious to introduce *Moringa oleifera* (MO) or “Murunga” as the “**miracle tree**”, since every part of it has a prodigious medicinal value. *Moringa* is a genus of medicinal plants that consists of 13 species. *Moringa* species show anti-inflammatory, anticancer, antioxidant, antidiabetic and antihyperglycemic properties; mainly owing to the high content of flavonoids, glucosides and glucosinolates. Traditional uses of MO are healing skin infections, anxiety, asthma, wounds, fever, diarrhea and sore throats.



MO is a fast-growing, slender trunked, deciduous plant native to tropical Asia but also naturalized in Africa and tropical America, with 10-12 m in height. It can be cultivated in any tropical or subtropical region of the world. People introduce MO as a “**never die tree**” because its uses seem to be endless and trees may survive despite

high altitudes or very dry and arid deserts with annual rainfall less than 400 mm. This natural powerhouse can be used to achieve goals such as good health and well-being.

### Chemicals present in *Moringa oleifera*

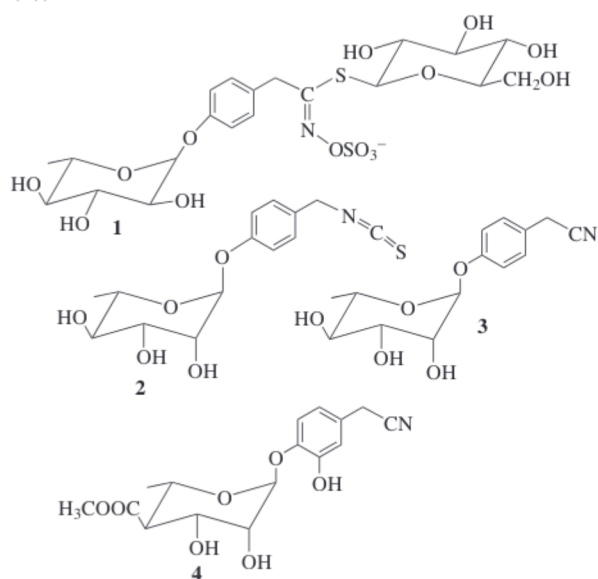
Phytochemicals are known as special chemical compounds, which are produced by plants through primary or secondary metabolic pathways. Phytochemicals (e.g. alkaloids, phytosterols, polyphenols, terpenoids *etc.*) play a vital role in improving the health due to their medicinal and pharmacological properties. Each part of this tree consists of a unique chemical composition; hence, the application of the plant component depends on the chemical nature of it. These compounds are mainly useful to build up a self-defense system against microorganisms and several diseases. Over 100 phytochemicals have been isolated from MO and some of them showed positive biological activities against various diseases.

### Leaves

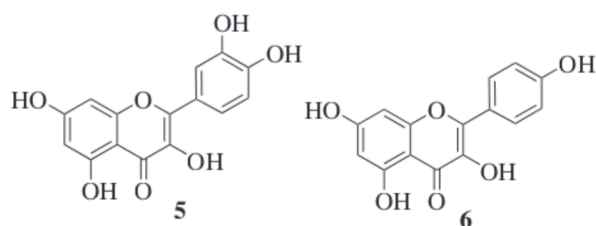
Most of the botanists and chemists pay more attention to carry out research on MO leaves relative to other parts because leaves are the centre of this powerhouse. Even though taste of the leaf is similar to

spinach, MO leaves have more **iron** content than the same mass of spinach leaves; 7 times the **vitamin C** in orange, 4 times the **vitamin A** in carrots, 3 times the **potassium** in banana, 4 times the **calcium** in milk, and twice the **proteins** in yogurt. These leaves also contain other vitamins namely, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, D, E and K; minerals such as Cu, Zn, Fe, Mg, Ca and K; and **all essential amino acids**. High **selenium** content present in these leaves provides the successive way to work antioxidants and vitamins together.

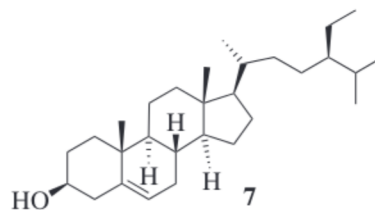
**Glucomoringin** (GMG) or 4-( $\alpha$ -L-rhamnopyranosyloxy) benzyl glucosinolates (**1**) is the most abundant **glucosinolate** compound present in the leaves. Glucosinolates such as GMG derivatives react with **myrosinase enzyme** to form **isothiocyanates** (e.g. GMG-isothiocyanate or GMG-ITC (**2**)), which are very stable at room temperature compared to normal isothiocyanates. Hence, these compounds can be easily utilized as anticancer, antidiabetic, antimicrobial and anti-inflammation agents. **Nitrile glycosides** present in MO leaves are used as anti-hypertension drugs for pulmonary hypertension (e.g. **niazirin** (**3**), **niaziridin** (**4**)) and medicine for cancers.



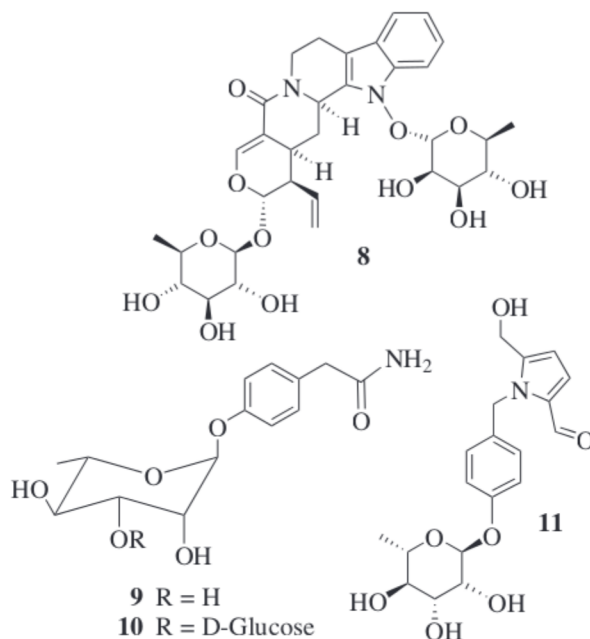
Flavonoids (e.g. **quercetin** (**5**), **kaempferol** (**6**), rutin, rhamnetin) play a vital role as antioxidants as they stabilize radicals produced in living cells. The concentrations of quercetin present in the leaves are as high as 100 mg/100 g, which is important to maintain the normal blood pressure.



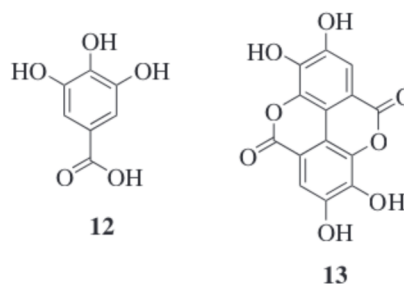
**$\beta$ -Sitosterol** (**7**) (57%), **campesterol** (23%) and **stigmasterol** (8%) are the major phyosterols extracted from MO leaves.

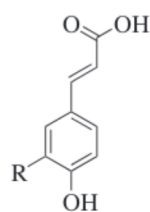


The bioactive alkaloids isolated from leaves include **vincosamide** (**8**), **marumoside-A** (**9**), **marumoside-B** (**10**) and a pyrrole-based derivative (**11**).



**Phenolic acids** are known to act as antioxidants. **Gallic acid** (**12**) is present in higher content in MO leaves. **Ellagic acid** (**13**), **ferulic acid** (**14**) and **caffeic acid** (**15**) are some of the other examples for phenolic acids.

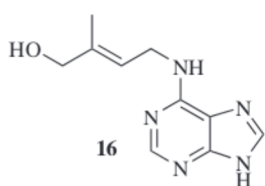




14 - R = OCH<sub>3</sub>

15 - R = OH

Phytohormones are important to regulate the growth of plants. **Zeatin (16)** is an adenine based cytokinin hormone present in MO leaves. This substance is important in slowing down the aging process.

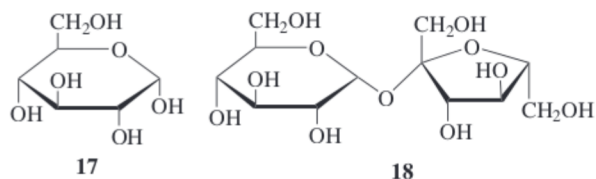


Although MO has the energy boosting ability, it does not contain caffeine. This property is empowered by NADH produced from niacin and vitamin B. Therefore, it increases the muscle, heart and brain functions. MO leaves act as a bio-cleaner in our body system by increasing the fecal excretion of cholesterol and flushing toxins from kidney.

Filipinos refer to MO as “**mother’s best friend**” because its leaves increase the milk secretion in breast-feeding mothers.

### Flowers

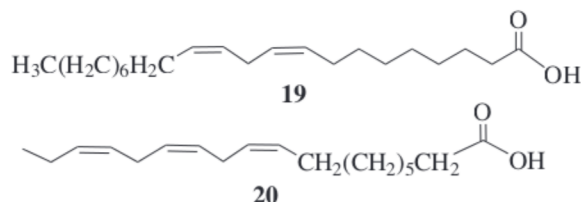
The flower of MO is yellowish white. It is bisexual and has a mild fragrant. This edible flower is composed of a remarkable content of **calcium** and **potassium**, as well as nine amino acids, sugars such as **D-glucose (17)**, **sucrose (18)** etc., waxes, and couple of flavanols (quercetin (5) and kaempferol (6)). It has a higher medicinal value and is used for curing inflammations, tumors, muscle pains, hysteria etc.



### Pods

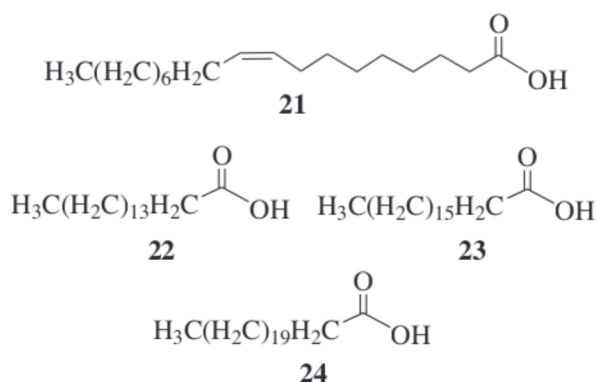
“**Drumstick**” is another name to introduce pods

of MO due to its appearance. These edible pods are highly fibrous and mainly contain thiocarbamates, isothiocyanate glycosides and polyunsaturated fatty acids (PUFA) such as oleic acid, **linoleic acid (19)**, palmitic acid and **linolenic acid (20)**. Isothiocyanate glycosides help to maintain healthy blood sugar levels, while PUFAs elevate the healthy lipid level or HDL. **Arginine** and **histidine** are the amino acids present in pods.

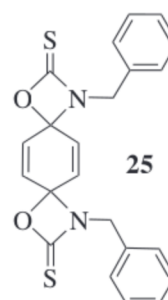


### Seeds

“Ben oil” can be extracted from seeds and it contains fatty acids with sweet, non-sticking, non-drying and rancidity-resistant properties. This oil is composed of **oleic acid (21)** (major), **palmitic acid (22)**, **stearic acid (23)** and **behenic acid (24)**, hence it is used as a cooking oil and to produce cosmetic products such as perfumes, hair dressings and lubricants for machines.



**Pterygospermin (25)** is a special compound present in the seeds, which has anti-microbial properties. Due to its disinfection nature, MO seeds are used in wastewater treatment processes, instead of Alum. These seeds act as bio sorbents; hence, they remove heavy metals such as Cu, As, Cr and Cd from water bodies.



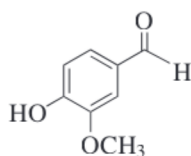
Most people consume MO seeds the same way as peas or roasted nuts since they contain high levels of vitamin C, moderate amounts of B vitamins, amino acids and dietary minerals. The presence of tannins, saponins, phenolics, phytates, flavonoids, terpenoids and lectins also play different favorable roles to improve the health of the body.

### Root and stem

Root and stem are composed of a mixture of phytochemicals such as flavonoids, alkaloids, phytosterols, phytohormones, glucosinolates, waxes, resins and traces of essential oils with a pungent smell.

Root extract shows favorable impact on neuro-transmittance as well as sex-hormone related properties. Juice or extracts taken from MO root is a good medicine for asthma, liver and spleen expansion. At lower concentrations, it produces a dose-dependent positive inotropic effect, and at higher concentrations, produces a dose-dependent negative inotropic effect as a hypotensive toxin. Filipinos use the juice of scraped trunk to treat cuts in their skin.

Various sugars such as L-arabinose, L-galactose, L-rhamnose, L-mannose, L-xylose and L-mannose, and **vanillin (26)** are other compounds that can be found in the gum of the stem. The chemical composition in the bark of MO has antifungal and antibacterial properties.



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It is important to know how to consume these edible parts (leaves, flowers, seeds and pods) without destroying the nutritional value of them. For example, boiling of leaves can destroy the medicinal value of bioactive compounds. Doctors' advice is to consume leaf powder with hot liquid drinks. The recommended dosage for an adult per day is 3 g (ca. one teaspoon) of leaf powder or 1.5 g of seed powder or root powder. However, excessive use of these herbal parts can cause unknown side effects.

In conclusion, MO contains bioactive compounds. It is an excellent source of nutrients and used as a medicinal plant to cure wounds and various diseases,

for purification of water, production of biodiesel and as a biopesticide. The leaf is the most widely used part of the plant and it is rich in vitamins, carotenoids, polyphenols, phenolic acids, flavonoids, glucosinolates, isothiocyanates, tannins, alkaloids and saponins.

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