

Review

## Noni: A new medicinal plant for the tropics

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**Noni (*Morinda citrifolia* L.) is a tropical plant belonging to the family, Rubiaceae. It is a small evergreen tree or shrub growing to a height of 3 to 6 m. Fruits are multiple, oblong, 5 to 7 cm long, soft, watery with a cheesy aroma. Fruits contain more than 150 compounds having nutraceutical properties. The major compounds isolated are scopoletine, octanoic acid, vitamin C, terpenoids, alkaloids, anthraquinones, beta sitosterol, carotene, vitamin A, amino acids, acubin, etc. Xeronine is a miracle ingredient responsible for all therapeutic properties of noni and it is reported to exist in noni as its precursor prexeronine. Noni is most important botanical and dietary supplement traded in international market. The fruit is marketed in different forms such as fermented and pasteurized noni juice, noni powder, noni capsules, etc. Noni is a valuable medicinal plant and it may prove to be one of the more diversely valuable agents in nature's medicine chest, and an enduring dietary supplement which serves the health needs of our country. Based on its ethnobotany, phytochemistry, production, processing and value addition as a highly nutritious medicinal plant, noni is discussed in detail.**

**Key words:** Noni, medicinal plant, nutritious, fermented, pasteurized.

### INTRODUCTION

Noni (*Morinda citrifolia*) is a small tree belonging to the coffee family, Rubiaceae. It is also known as Indian mulberry, awl tree, cheese fruit, nino, nona, etc. For over 2000 years or more, the plant has been identified as a medicinal plant by Polynesians and Tahitians and they used it for therapeutic purposes. Almost all parts of the plant are used for one or other purposes. The fruits were used in food preparations and as medicine. Different parts of the plant such as leaves, stem and roots were also used as medicine. In Polynesia and Southeast Asia, application of plant is extended to cure cough, cold, pain, liver disease, malaria and blood pressure (Dixon et al., 1999). Considering the medicinal value of the plant,

National Medicinal Plant Board has included noni in the list of plants approved for cultivation.

### ORIGIN AND DISTRIBUTION

The plant is believed to have originated from South-east Asia, Oceania and tropical Australia, extending from Polynesia to India. It is now grown throughout the tropics and is cultivated on a commercial scale in Latin America, from Mexico to Columbia and Venezuela, including Costa Rica, Panama, Kenya, Florida and the West Indies (Abbott and Shimazu, 1985). In India, the plant is growing

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wild in the coastal areas of Kerala, Karnataka, Tamil Nadu, and Orissa. The highest naturally grown populations are seen in Andaman and Nicobar Islands.

## BOTANICAL DESCRIPTION

The genus name '*Morinda*' was derived from two Latin words *morus* means mulberry and *indicus* means India, in reference to similarity of fruit of noni to that of true mulberry (*Morus alba*). The species name indicates resemblance of plant foliage with that of citrus species. Noni is evergreen tree or shrub growing to a height of 3-6 m. Noni has a rooting habit similar to that of coffee and citrus with an extensive lateral root system and deep tap root.

Leaves are opposite pinnately reticulate veined, and glossy. Blades are membranous, elliptic to elliptic-ovate, 20 to 45 cm long, 7 to 25 cm long and glabrous with prominent veins. Petioles are stout, 1.5 to 2 cm long. Flowers are perfect; funnel shaped, grouped in globose head or in small clusters, at the leaf axis. The corolla is white, 5-lobed with greenish white corolla tube, 7 to 9 mm long. The flowers give off a sweet fragrance. *Morinda citrifolia* fruits several times annually, producing multiple or aggregate fruits, oblong 5 to 7 cm long with circular scars, which are green when unripe and yellowish-white when fully ripe. The fruits have a soft, watery flesh, and a cheesy aroma which becomes increasingly pronounced and pungent during the ripening process. It is also called starvation fruit.

Noni seeds are small, 4 mm long, reddish-brown, oblong-triangular, and have a conspicuous air chamber. They are buoyant and hydrophobic due to this air chamber and their durable, water-repellent, fibrous seed coat. The seed coat is very tough, relatively thick, and covered with cellophane-like parchment layers. A single large noni fruit can contain well over 100 to 150 seeds. The seeds are edible when roasted.

## SOIL AND CLIMATIC CONDITIONS

Noni is an unusual plant, because it can easily tolerate and thrive in a wide range of soils and conditions. The plant is highly tolerant to acidic, saline and alkaline soil conditions and grows well from a pH range of 4.4 to 9. In Hawaii, it can grow under almost any soil conditions at low altitudes. Heavy, compact soils and flood prone areas should be avoided for noni cultivation.

Noni can be grown in wide climatic conditions such as tropical, subtropical, dry and humid climates. It grows naturally in wet to moderately wet conditions, also grown in brackish water. It comes up very well between 20-38°C temperatures. It can be grown from sea level to 2000 m above mean sea level.

## HARVESTING AND HANDLING

Under favourable growing conditions, noni plants may begin to produce small flowers and fruits about 9 months to 1 year of age. Fruits can be harvested at this early stage, although they are generally small and few. Some farmers choose to forego harvest during the first or second years in favour of pruning back the branches instead. In Hawaii, noni fruits are harvested year round, although there are seasonal trends in the amount of flowering and fruit production that may be affected or modified by the weather and by fertilizer and irrigation. Fruit production may diminish somewhat during the winter months in Hawaii. A given noni field is usually harvested from two to three times per month.

Noni fruits can be picked at any stage of development, depending on the intended processing method. Some producers prefer green fruits, whereas other processors prefer the hard white noni fruits for processing. Most noni juice processors accept or prefer the "hard white" stage of fruit development for noni juice production, because the fruits ripen quickly once that stage of development is reached.

Noni fruits are harvested by hand by picking the individual fruits from the branches. They are placed in baskets or bags or placed in bins for transport to the processing facility. Noni fruits do not bruise or damage easily, and usually no special padded containers or other precautions are needed to prevent fruit significant fruit damage. Green or unripe yellow noni fruits are very hard-skinned and durable, and therefore resistant to superficial damage and bruising during shipping and handling. Noni fruits at this stage of development will ripen overnight or in a few days at room temperature and can be processed for juice immediately thereafter. Furthermore, exposure of noni fruits to direct sunlight or to warm temperatures immediately after harvest is not a significant concern. So, noni fruits need not be refrigerated after harvest and are usually not refrigerated.

## PROCESSING OF NONI

### Traditional noni juice

Freshly picked noni fruits after washing are allowed to air-dry on raised tables before they are processed for juice. The most efficient noni juice extraction by weight is obtained when ripe, soft, translucent fruits are placed into the juice collection vessels. Ripe noni fruits are placed into a juice collection vessel for two months or longer. During this time, the noni juice separates (drips) gradually from the pulp. The juice collection and fermentation vessels should be made of glass, stainless steel or food-grade plastic. The noni juice collects inside the containers and ferments as it gradually seeps and sweats from the fruits. The juice appearance is initially an amber or

golden colored liquid that gradually darkens with age. After the collection and fermentation process is complete, the juice is drained from spigots at the base of containers (and filtered). Fresh air is excluded from these containers, and contact between the juice and fresh air is minimized throughout the process. The final noni juice product is decanted, filtered and bottled.

#### **Extraction efficiency (traditional method, drip extraction)**

After approximately 2 months, most of the noni juice separates naturally from the fruit pulp and may be drained from the container and filtered. The recovery of juice by this traditional method is approximately 40-50% of the original fruit weight. Therefore, using this method, 100 pounds of fruit may yield about 40-50 pounds of juice, or about 4.5 to 5.0 gallons of juice.

After all the noni juice is drained from the collection and fermentation vessel, the residual pulp may be pressed to express the remaining juice fluids. The leftover pulp and seeds may be discarded, or they may be dehydrated and used in other noni products.

#### **Non-traditional noni juice (fresh-squeezed, filtered and non-fermented)**

Fresh-squeezed noni juice has a sweeter (less acidic), fruitier flavor than aged, fermented noni juice. When noni fruits are ripe, the juice is separated from the pulp and seeds using a fruit press. Up to 65% juice recovery by weight is possible using this method of juice extraction. Home producers of noni juice use a wide range of fruit pressing methods, from squeezing by hand through cheesecloth, paint strainers, to more elaborate home-made pressing devices

A hydraulic fruit press is used for making fresh-squeezed noni juice. Ripe fruits are loaded into the press through the top door. Juice is pressed from the pulp and bottled immediately.

Fresh-squeezed noni juice has a golden amber color and has significantly less sediment than fermented noni juice collected by the traditional method. Conversely, fermented noni juice produced by the traditional method is very dark brown, resembling the colour and texture of soy sauce.

Fermentation of fresh-squeezed juice can be arrested by refrigeration or by pasteurization. This will preserve the fruity, sweet taste of the non-fermented juice. Or, the fresh-squeezed juice may be allowed to ferment naturally in bottles or containers for a period of weeks or months prior to marketing or consumption.

#### **Amended or mixed noni juice products**

Noni juice may be mixed with other juices of flavorings to

improve the palatability of the product (e.g., with raspberry, strawberry or grape flavors). Some producers choose to dilute their juice with water and sweeten the product with the addition of sugar.

In Hawaii, noni fruit pulp may be chopped, dehydrated and powdered and used in reconstituted noni juice products for the dietary supplement industry. These products are standardized to approximately 0.8% noni active polysaccharides (which is equivalent to the noni active polysaccharide content of pure aged noni juice).

Noni juice itself may be evaporated and formed into a powder that can be used in various products, including reconstituted juices. Noni juice powder is highly hygroscopic (attracted to water) and must be mixed with a non-hygroscopic carrier to enable it to retain its powdered formulation.

### **CHEMICAL CONSTITUENTS OF NONI**

Table 1 contains a partial list of chemical constituents isolated from noni, and their proposed or documented medicinal qualities or cultural significance.

#### **Activity of ripe noni fruit and its constituents**

The following is a partial list of the phytochemical constituents in ripe noni fruit, and some of their known biological activities.

#### **Xeronine**

Xeronine is a miracle ingredient responsible for all therapeutic properties of noni and it is reported to exist in noni as its precursor prexeronine. Xeronine is an alkaloid almost impossible to detect. No independent laboratory has identified or quantified xeronine in any noni product (Heinicke, 1999).

### **MEDICINAL USES OF NONI**

Noni fruit juice concentrates potentially activate Cannabinoid 2 which exerts beneficial immunomodulation effects on human body (Palu et al., 2008). Noni extracts demonstrated hypotensive activity, and have been shown to have ACE-inhibitory activity. Since ACE inhibitors are commonly prescribed to treat high BP, this activity points to a potential therapeutic use. It is traditionally used in Malaysia for the treatment of diabetes mellitus. The aqueous extract of noni fruit appears to contain plant compounds that have substantial hypoglycemic property (Jin, 2007). A polysaccharide-rich substance from the fruit juice of noni, noni-ppt is responsible for this activity. It showed synergistic and additive effects when combined

**Table 1.** A partial list of chemical constituents isolated from noni, and their proposed or documented medicinal qualities or cultural significance.

Noni plant organ(s)	Compound(s)	Proposed or documented effects of compounds
	Alkaloids (xeronine)	In theory, xeronine enhances enzyme activity and protein structure
Fruit and fruit juice	Polysaccharides (glucuronic acid; galactose; arabinose; rhamose; glycosides; trisaccharide fatty acid ester)	Immuno-stimulatory; immuno-modulatory; anti-bacterial; anti-tumor; anti-cancer.
	Scopoletin	Dilates vasculature and lowers blood pressure; anti-bacterial and anti-fungal; anti-inflammatory; analgesic; histamine-inhibiting; arthritic conditions; allergies; sleep disorders; migraine headaches; depression; Alzheimer's disease.
	Vitamins and Minerals: magnesium; iron; potassium; selenium; zinc; copper; sulfur; ascorbic acid (vitamin C).	The positive medical effects of the vitamins and minerals in noni juice are well documented. For any questions or medical and health concerns, consult a physician or dietician.
Foliage and cell suspensions	Anthraquinones (damnacanthal)	Antiseptic and antibacterial effects in digestive tract ( <i>Staphylococcus</i> , <i>Shingela</i> , <i>Salmonella</i> ).
	Glycosides (flavonol glycoside; iridoid glycoside, "citrifolinoside")	Anti-cancer effects: (DPPH free radical scavenging activity; inhibition of UVB-induced Activator Protein-1 activity in cell cultures.
Roots	Anthraquinones (damnacanthal)	Inhibits formation of lung carcinoma in mice.
	Morindin and Morindone	Dyes, yellow and red colorants used for tapa cloth; anti-bacterial.

Source: <http://www.noni.org/>.

with broad spectrum of chemotherapeutic drugs (Hirazumi and Furusawa, 2003). The alcoholic extracts of noni fruits is known to have analgesic effect and it is commonly used for opened sores and inflamed areas of the skin in multiple ethnic groups (Punjanon and Nandasri, 2005).

Ripe noni fruit contains a concentration of anthraquinones including one called damnacanthal, which possess purgative activity. This accounts for the "cleansing" effect described by many users. In the cases of sluggish digestion and slow moving bowels, noni can exert a stimulating and thereby beneficial effect, helping to increase peristalsis and cleanse the colon.

Anecdotal accounts of anti-inflammatory effects resulting from noni fruit consumption are too numerous to dismiss. The anti-inflammatory effects of asperuloside, eugenol and scopoletin present in ripe noni fruit would support such a claim. Other agents may possess additional anti-inflammatory activity for the aging population (Amy and Noelani, 2009).

In China, Japan, and Tahiti, various parts of the tree serve as tonics and to treat fever, eye and skin problems, gum and throat problems as well as constipation, stomach pain, or respiratory difficulties. In Malaysia, heated noni leaves applied to the chest are believed to relieve

coughs, nausea, or colic. The fruit is used as a shampoo in Malaysia, where it is said to be helpful against head lice. The noni fruit is taken, in Indochina especially, for asthma, lumbago and dysentery. As for external uses, unripe fruits can be pounded, then mixed with salt and applied to cut or broken bones. In Hawaii, ripe fruits are applied to draw out pus from an infected boil. The green fruit, leaves and the root/rhizome have been used to treat menstrual cramps and irregularities. Noni seed oil is abundant in linoleic acid that may have useful properties when applied topically on skin, for example, anti-inflammation, moisture retention.

## MARKETING OF NONI FRUITS

Noni is distributed in more than 50 countries across the globe. Its health benefits have been realized by millions of consumers. Noni does not require large amount of fertilizers and irrigation and it grows even in drought prone areas. As all parts of noni are marketed as different products, marketing opportunities have been increased. Over 200 companies are selling noni products. Noni bears 1.5-2 q of fruits/plant/year. The profit is about Rs.2.25 lakhs/acre/year. Even if the yield is 50% of the expected yield, overall the noni can be a blessing for the farmers of all categories and having any type of land.

Noni is most important botanical and dietary supplement traded in international market. The fruit is marketed in different forms such as fermented and pasteurized noni juice, noni powder, noni capsules, etc. Now it is widely available in health food stores, pharmacies, grocery stores and also through the online markets. Noni juice was number one in 2005, for sales of single herbs in the USA, with sales estimated at about \$250 million (<http://www.ctahr.hawaii.edu/noni/>).

### Conflict of Interests

The author(s) have not declared any conflict of interests.

## CONCLUSION

Considering the positive discoveries made with noni fruit thus far, there is good reason to anticipate that further studies will prove the fruit and its preparations beneficial to health in numerous ways. Noni is a valuable medicinal plant. And it is likely to become an increasingly sought-after dietary supplement. Noni may prove to be one of the more diversely valuable agents in nature's medicine chest, and an enduring dietary supplement which serves the health needs of many.

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