

MORINDA CITRIFOLIA LINN; A MEDICINAL PLANT WITH DIVERSE PHYTOCHEMICALS AND ITS MEDICINAL RELEVANCE

***Mahanthesh M.C¹, Manjappa A.S¹, Shindhe M.V¹, Jamkhandi C.M¹, S.S. Jalapure²,
S. S. Patil³**

¹Tatyasaheb Kore College of Pharmacy, Warananagar, 416 113, Dist: Kolhapur. Maharashtra State, India.

²KLE College of Pharmacy, Belgaum, Karnataka State, India.

³Ashokrao Mane College Pharmacy Pethvadagaon, India.

Article Received on
20 October 2013
Revised on 22 November
2013,
Accepted on 17 December
2013

***Correspondence for**

Author:

Mahanthesh M.C.

Tatyasaheb Kore College of
Pharmacy, Warananagar, 416
113, Dist: Kolhapur.
Maharashtra State, India.

mc_mahanthesh@rediffmail.com

ABSTRACT

The entire plant of *Morinda Citrifolia* L. (Noni) from the family Rubiaceae is well known for its medicinal values. It is an edible plant in which the leaves and fruits can be used as emergency food. This can also be used as drink, medicine and colorful dye. The medicinal applications are attributed to the presence of various phytochemical constituents. The plant is rich various phytochemicals like Anthraquinone glycoside, glycosides, terpenes, sterols, organic acids and amino acids. The objective of the present article is to throw light on update report of applications and phytochemicals with chemical structures. It is concluded that the phytochemicals like Xeronines, Scopoletin, damnacanthol and Asperulosidic acid show activities antiathritis, antimicrobial, antiseptic and antitumor respectively. The article is useful for future investigators to explore the plant.

Keywords- *Morinda citrifolia*, Medicinal plant, Phytochemicals, Noni fruit.

1. INTRODUCTION

Herbal and natural products of folk medicine have been used for centuries in every culture throughout the world. Scientists and medical professionals have shown increased interest in this field as they recognize the true health benefits of these remedies. “Let food be your medicine and let medicine be your food” was advised by the father of medicine, Hippocrates, over two millennia ago. It’s still true today that “you are what you eat.” Folk medicine in

different cultures has a long history of ancestors creating primitive medicines during their struggles against natural calamity and disease. While searching for food, the ancient found that some foods had specific properties of relieving or eliminating certain diseases, and maintaining good health. It was the beginning of herbal medicine^[1]. The same story occurred in Polynesia. Among the medicinal plants discovered by the ancestors of Polynesians, *Morinda citrifolia* L (Noni) is one of the traditional folk medicinal plants that have been used for over 2000 years in Polynesia^[2]. It has been reported to have a broad range of therapeutic and nutritional value^[3].

Morinda Citrifolia L. (Noni) from the family Rubiaceae has been used by Polynesians for over 200 years for two main purposes. First, the roots and barks have been used as a dye for traditional and ceremonial cloths. Second, every part of the plant has been used medicinally in treating a variety of ailments^[4-5]. The use of alternative medicine and herbal products by the general public is becoming increasingly popular^[6]. Formulations of St John's wort, alove vera, ginkgo biloba, Echinacea, chitosan, saw palmetto, ginseng, and others can be found in millions of medicine cabinets around the country. Often, these remedies are innocuous, but on occasion, they can cause very serious health consequence^[7].

Many plants belonging to *Morinda* spp. are valuable traditional herbs in the Austronesia and oriental countries. *Morinda citrifolia*, commonly named "noni" has a long history of utilization throughout the Pacific Polynesia and is deemed to be the second most important herb plant in the Hawaiian Islands^[8]. Noni is not a medicine but it is an herbal dietary supplement and a Health Enhancer^[9]. The Noni plant (Fig 1a) is a small evergreen tree found growing in open coastal regions at sea level and in forest areas up to about 1300 feet above sea level. The plant is often found growing along lava flows. It's identifiable by its straight trunk, large, bright green and elliptical leaves, white tubular flowers (Fig 1b), and its distinctive, ovoid, "grenade-like" yellow fruit (Fig. 1c and 1d).

The fruit can grow in size up to 12 cm or more and has a lumpy surface covered by polygonal-shaped sections. The seeds (Fig 1c), which are triangular shaped and reddish brown, have an air sac attached at one end, which makes the seeds buoyant. This could explain, in part, the wide distribution of the plant throughout the Polynesian islands. The mature Noni fruit has a foul taste and odor^[10-11].



Figure 1. Photocopy of different parts of noni (a) plant (b) white tubular flowers (c) fruit with seeds; (d) matured fruits.

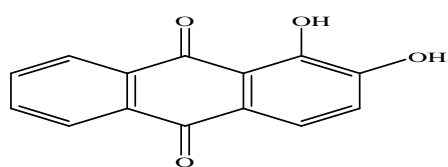
The genus *Morinda* (Rubiaceae), including the species *Morinda citrifolia* L., is made up of around 80 species. *Morinda citrifolia* is a bush or small tree, 3–10m tall, with abundant wide elliptical leaves (5–17 cm length, 10–40 cm width). The small tubular white flowers are grouped together and inserted on the peduncle. The petioles leave ring-like marks on the stalks and the corolla is greenish white^[12,13,14,15 &16]. The noni fruit (3–10 cm length, 3–6 cm width) is oval and fleshy with an embossed appearance. It is slightly wrinkly, semi-translucent, and ranges in colour from green to yellow, to almost white at the time of picking. It is covered with small reddish brown buds containing the seeds. The ripe fruit exhales a strong butyric acid-like rancid smell. The pulp is juicy and bitter, light dull yellow or whitish, gelatinous when the fruit is ripe; numerous hard triangular reddish-brown pits are found, each containing four seeds (~3.5 mm)^[17]. *Morinda citrifolia* is a perennial bush and it is possible

to find fruits at different stages of maturity on the same plant at the same time. The species is generally found from sea level to 400m altitude, although it adapts better to coastal regions^[18]. Under favorable conditions, the plant bears fruit about nine months to one year after planting. At this stage, the fruits can be harvested, but they are generally small and the yield per tree is low. Some producers choose not to harvest in the first year, and they prune in order to let the bush grow stronger. In Hawaii, noni fruits are harvested throughout the year, although there are seasonal patterns in flowering and fruit bearing (meteorological factors, fumigation, and irrigation)^[19-20]. The noni plant is sometimes known as "Indian Mulberry" and many islanders refer to it as "Magic Fruit"^[21].

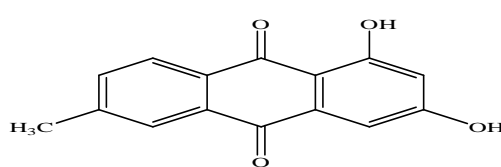
This review reports mainly on the various phytochemicals present in the different parts of the noni plant along with their chemical structures. Also, this review describes various health benefits, traditional and medicinal applications of noni, and some statistical data of clinical survey on some marketed noni products.

2. Phytochemicals of Noni

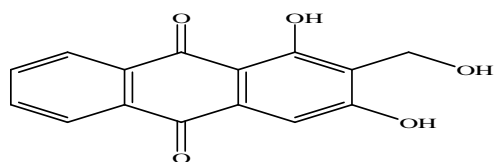
About 160 phytochemical compounds have been already identified in the noni plant, and the major micronutrients are phenolic compounds, organic acids and alkaloids. Of the phenolic compounds, the most important reported are anthraquinones (Table 5) like damnacanthal, morindone, morindin, etc. (Fig 2), and also aucubin, asperuloside, and scopoletin (fig 3)^[22]. It also contains steroidal glycosides (Fig 4). The main organic acids are caproic and caprylic acids (Fig 5)^[23], while the principal reported alkaloid is xeronine^[24].



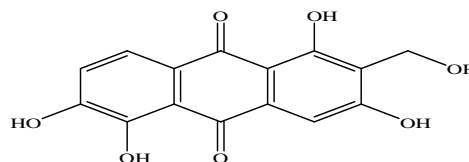
Alizarin



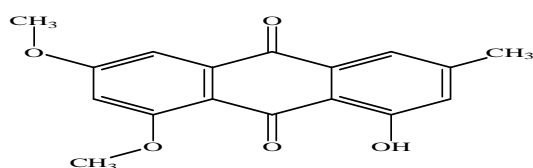
1, 3-dihydroxy-6-methyl Anthraquinone



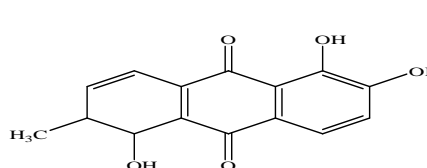
Lucidin



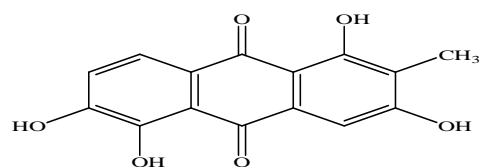
5, 6-dihydroxy lucidin



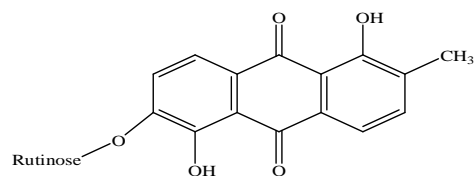
2-methyl-4-hydroxy-5,7-dimethoxyanthraquinone



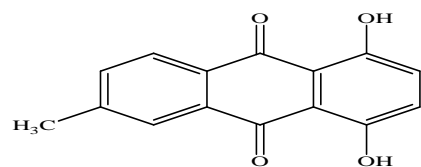
Morindone



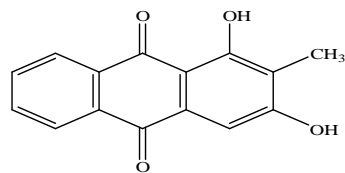
3-hydroxy morindone



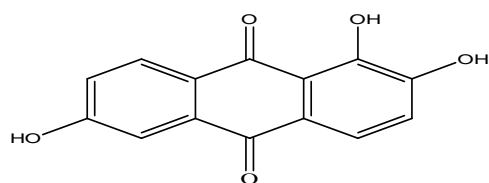
Morindion



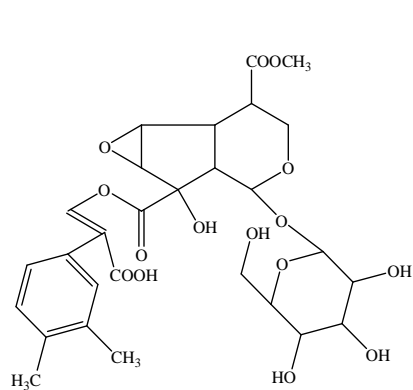
Morindanidrine



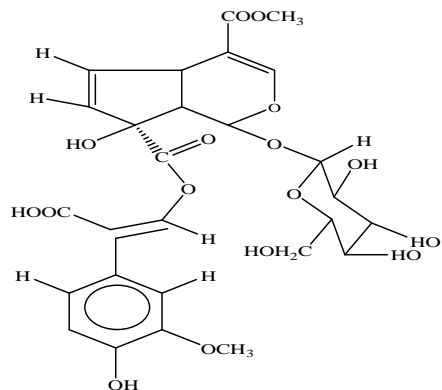
Rubiadine



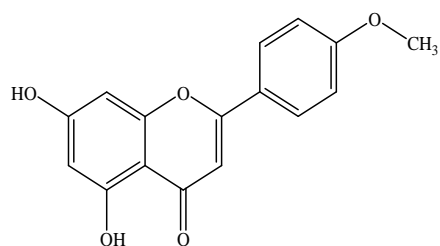
Sorandjidiol

Figure 2. Structure of Anthraquinone Glycosides of Noni fruit.

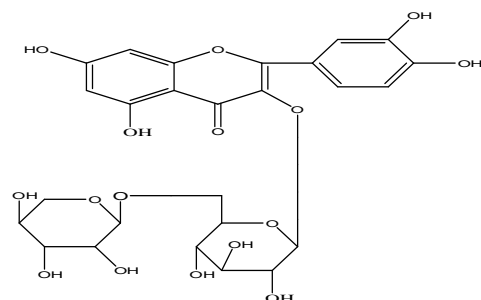
Citrifolinoside-B



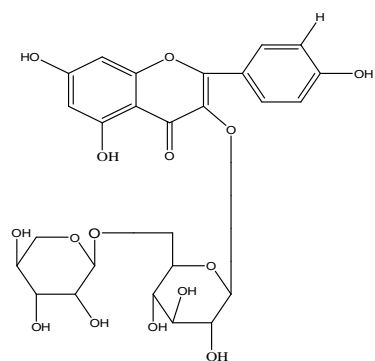
Citrifolinoside-A



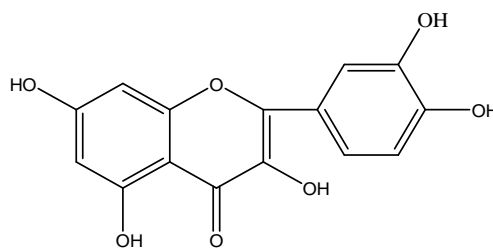
Aracetin



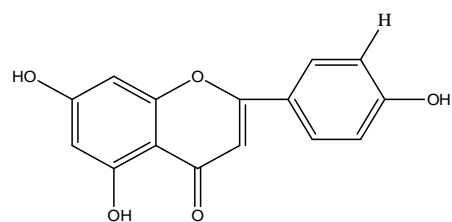
Pyranoside (Rutin)



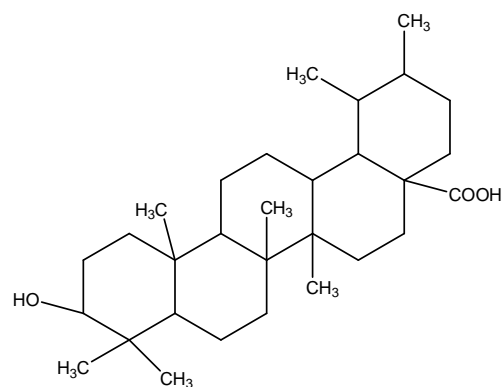
Glucopyranoside



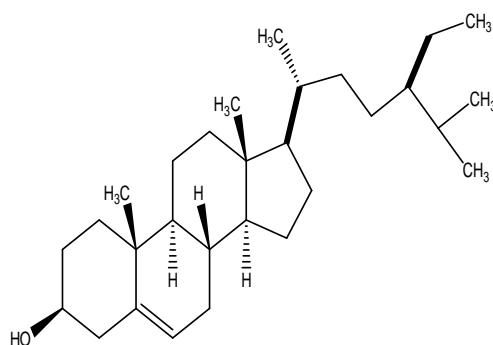
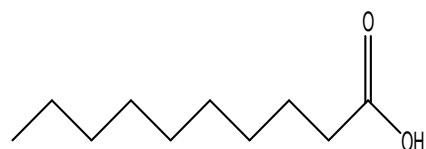
Quercetin



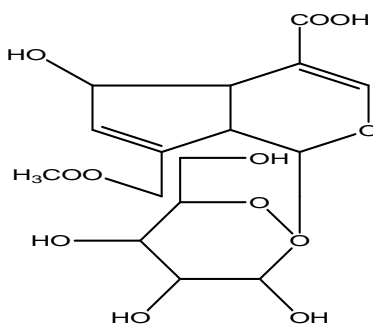
Kaempferol

Figure 3. Structure of Miscellaneous glycosides of Noni.

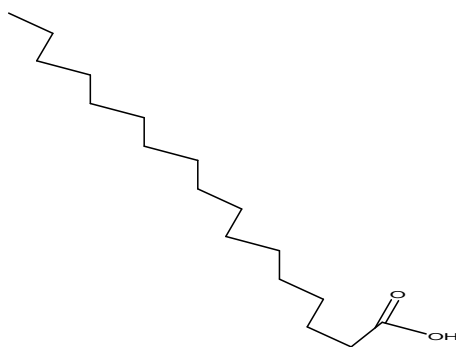
Ursolic acid

 β - sitosterol**Figure 4. Structures Steroidal Constituents of Noni.**

Caproic acid



Asperulosidic acid



Octanoic acid

Figure 5. Acidic constituents of Noni fruit.

However, chemical composition differs largely according to the part of the plant (Table 2). The complete physico-chemical composition (Table 1) of the fruit has not yet been reported and only partial information is available on noni juice.

Table 1: The some important chemical constituents of noni along with their location.

phytochemicals	Location	Reference
Anthraquinones (fig.2)		
Alizarin	Root, root bark, fruit	[23], [25],[31],[32],[33]
1,8-dihydroxy-2-methyl-3,7-dimethoxyanthraquinone	Plant	[34]
3-O- β -Primeveroside	Plant	[34]
1,3-dihydroxy-2-methylanthraquinone	Plant	[34]
Lusidin- ω -ethyl ether	Plant	[34]
Lusidin- ω -butyl ether	Plant	[34]
1,3-dihydroxy-6-methyl Anthraquinone	Root	[26]
Trioxymethyl anthraquinone monoethyl ether	Root, bark	[23]
8-hydroxy-8methoxy-2-methyl-anthraquinone	Root	[25]
2-methyl-3,5,6-trihydroxy-anthraquinone	Plant	[25], [35]

Lucidin	Plant	[32]
5,6-dihydroxy lucidin	Plant	[25]
2-methyl-4-hydroxy-5,7-dimethoxyanthraquinone	Flower	[36]
Morindone	Root, heartwood, root bark	[23], [32], [33], [35], [36]
3-hydroxy morindone	Plant	[25]
Damnacanthol	Root, heartwood	[36]
Morenone 1	Root	[25]
Morenone 2	Root	[25]
Morindadiol	Root bark	[23]
Morindanidrine	Root bark	[23]
Morindine	Root bark	[23], [25], [26], [31]
Rubiadine	Root	[31], [32]
Rubiadine monomethyl ether	Root bark	[23]
Glycosides		
Asperuloside tetra acetate	Fruit	[31], [33], [26]
Citrifolinoside-B	Leaves	[36]
Citrofolinin-A	Leaves	[37]
β -D-glucopyranoside	Leaves	[36]
β -D-galactopyranoside	Leaves	[36]
Aracetin	Flower	[36]
Quercetin (Rutin)	Leaves	[38]
Kaempferol	Leaves	[38]
Terpenes		
Sorandjidiol	Root bark	[23], [31], [32]
Ursolic acid	Leaves	[31], [33], [36]
Carotene	Plant	[33]
Sterols		
β - sitosterol	Leaves	[31], [33], [36]
Acids		
Caprylic acid	Fruit	[23], [29], [31], [33], [36]
Caproic acid	Fruit	[23]

Ascorbic acid	Fruit	[39]
Asperulosidic acid	Fruit	[40]
Hexanoic acid	Fruit	[23]
Octanoic acid	Fruit	[41], [36]
Linoleic acid	Plant	[33]
Amino acids		
Alanine	Leaves	[36], [42]
Serine	Leaves	[23], [31]
Tryptophan	Leaves	[23], [31]
Tyrosine	Leaves	[23], [31]
Threonine	Leaves	[23], [31]
Valine	Leaves	[23], [31]
Cysteine	Leaves	[23], [31]
Glutamic acid	Leaves	[23]
Glycine	Leaves	[23], [31]
Histidine	Leaves	[23], [31]
Isolucine	Leaves	[23], [31]
Lucine	Leaves	[23], [31]
Methionine	Leaves	[23], [31]
Phenyl alanine	Leaves	[23], [31]
Proline	Leaves	[23], [31]
Arginine	Leaves	[23]
Asparitic acid	Leaves	[23]
Esters		
Ethyl caprylate	Fruit	[23], [29], [31], [33]
Ethyl caproate	Fruit	[23]
Methyl octanoate	Fruit	[41]
Methyl decanoate	Fruit	[41]
Ketones		
2-heptanone	Fruit	[41]
Lactone [(E)-6-dodeceno- γ -lactone]	Fruit	[41]

Sugars		
Pentose	Root bark	[23]
Hexose	Root bark	[23]
Glucuronic acid	Fruit	[43], [44]
Galactose	Fruit	[43], [44]
Aarabinose	Fruit	[43], [44]
Rhamnose	Fruit	[43], [44]

Table 2: Traditional medicinal applications of noni plant parts ^[49].

Plant Part Used	Traditional Medicinal Uses
Leaves:	Relieves cough, nausea, colic (Malaysia), tuberculosis, sprains, deep bruising, and rheumatism, bone fractures, dislocations, hypertension, stomach ache, and diabetes, loss of appetite, urinary tract ailments, abdominal swelling, hernias, and vitamin A deficiency.
Fruit:	Lumbago, asthma, dysentery (Indochina), head lice (Hawaii), wound poultice, broken bones, sores or scabs, sore throat, peeling and cracking of toes and feet, cuts, wounds, abscesses, mouth and gum infections, toothaches, appetite and brain stimulant food, boils, carbuncles, tuberculosis, sprains, deep bruises, rheumatism, stomach ulcers, hypertension.
Fruit juice:	Regulate menstrual flow, urinary tract problems, arthritis.
Stem:	Jaundice, hypertension.
Seed:	Scalp insecticide, insect repellent.
Flowers:	Sties.
Leaves, flowers:	Eye conditions, skin wounds, abscesses, gum and throat disease,
Fruit, bark:	Respiratory ailments, constipation, fever, laxative.
Root or stem bark:	Typically used to treat inflammation or infections.

The fruit contains 90% of water and the main components of the dry matter appear to be soluble solids, dietary fibers and proteins. The fruit protein content is surprisingly high, representing 11.3% of the juice dry matter, and the main amino acids are aspartic acid, glutamic acid and isoleucine. Minerals account for 8.4% of the dry matter, and are mainly

potassium, sulfur, calcium and phosphorus; traces of selenium have been reported in the juice^[25].

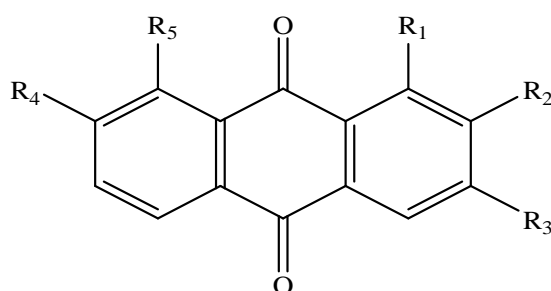
Vitamins have been reported in the fruit, mainly ascorbic acid (24–158 mg/100 g dry matter)^[26-27], and provitamin A^[28]. Phenolic compounds have been found to be the major group of functional micronutrients in noni juice: damnacanthal, scopoletin, morindone, alizarin, aucubin, nordamnacanthal, rubiadin, rubiadin-1-methyl ether and other anthraquinone glycosides have been identified in noni (Table 5).

Table 3: Health benefits and mechanisms of noni phytochemicals

Phytochemical	Benefits and Mechanism
Xeronines (proxeronine & proxeroninase):	Alkaloid that interacts with structurally abnormal proteins to convert them into their proper conformation; thought to be a critical normal metabolic co regulator; aids in hypertension, menstrual cramps, arthritis, ulcers, musculoskeletal injuries, indigestion, depression, and addictions.
Scopoletin:	Dilates vasculature, anti-bacterial, anti-fungal, anti-inflammatory, analgesic, histamine-inhibiting, serotonin modulator; aids in arthritis, allergies, migraines, depression, hypertension.
Anthraquinones (damnacanthal)	Antiseptic and anti-bacterial effects.
Polysaccharides (galactose, arabinose, rhamnose, lucuronic acid):	Immunostimulatory, immunomodulatory, anti-tumor effects; may play a role in the cancer-fighting benefits of noni.
Glycosides (rutin, asperulosidic acid):	Free radical scavengers, inhibition of UVB-induced activator protein-1 activity; role in cancer-fighting effects.
Amino acids and essential fatty acids:	Building blocks for protein, fats, and oils; necessary for healthy skin, maintenance of normal nervous system, cardiovascular system, and cellular function.

Table 4. Literature survey on biological activity of noni products

Biological Activity	Noni Product	Report
Anthelmintic activity	Ethanol extract of tender leaves	Death of human parasitic nematode worm, <i>Ascaris Lumbricoides</i> within a day ⁵⁰ .
anti-tumour activity on Lewis lung carcinoma in mice	The fruit juice of Noni contains a polysaccharide-rich substance	A significant increase (119%) was observed in the life span of C57BL/6 mice implanted with Lewis lung carcinoma ⁵¹
Analgesic activity	Noni fruit juice	Noni fruits possesses analgesic and tranquilizing Activites ⁵²
Hypotensive activity	Ethanol Noni root extract	Lowered the blood pressure in an anesthetized dog ⁵³
Free-radical-scavenging activity	Noni juice and powder	Decreased its free radical-scavenging activity ⁵⁴

**Table 5. General Structure and various Anthraquinone Glycosides**

Name of compound	R ₁	R ₂	R ₃	R ₄	R ₅
1,8-dihydroxy-2-methyl-3,7-dimethoxyanthraquinone	OH	CH ₃	OCH ₃	OCH ₃	OH
3-O-β-Primeveroside	OH	CH ₂ OH	O-β Prim	H	H
1,3-dihydroxy-2-methylanthraquinone	OH	CH ₃	OH	H	H

Lusidin- ω -ethyl ether	OH	CH ₂ OCH ₂ CH ₃	OH	H	H
Lusidin- ω -butyl ether	OH	CH ₂ OCH ₂ CH ₂ CH ₂ CH ₃	OH	H	H
Damnacanthol	OCH ₃	CH ₂ OH	OH	H	H

Damnacanthol is an anthraquinone that has been characterized recently and has some important functional properties (mainly anti-carcinogenic). Scopoletin is a coumarin that was isolated in 1993 at the University of Hawaii and has been found to have analgesic properties as well as a significant ability to control serotonin levels in the body^[29]. Other researchers have shown that scopoletin may also have anti-microbial and anti-hypertensive effects^[25]. Different Hawaiian teams^[30] reported the presence of a novel component, proxeronine, in the noni: it would be the precursor of xeronine, an alkaloid that is claimed to combine with human proteins, improving their functionality. These authors attribute most of all the beneficial effects of noni to xeronine. Nonetheless, neither the chemical characterization of this alkaloid has been published nor the method used to assess its content.

About 51 volatile compounds have been identified in the ripe fruit, including organic acids (mainly octanoic and hexanoic acids), alcohols (3-methyl-3-buten-1-ol), esters (methyl octanoate, methyl decanoate), ketones (2-heptanone), and lactones [(E)-6-dodecenog lactone]^[31].

3. Applications of Noni

3.1. Traditional Applications

The Polynesians utilized the whole Noni plant in various combinations for herbal remedies. The fruit juice is in high demand in alternative medicine for different kinds of illnesses such as arthritis, diabetes, high blood pressure, muscle aches and pains, menstrual difficulties, headaches, heart disease, AIDS, cancers, gastric ulcers, sprains, mental depression, senility, poor digestion, atherosclerosis, blood vessel problems, and drug addiction. Scientific evidence of the benefits of the Noni fruit Juice is limited but there is some anecdotal evidence for successful treatment of colds and influenza^[45]. Allen reported some information on the ethnobotanical properties of Noni. He said that the fruit is used as deobstruent and emmenagogue^[46]. Isabel Abbott, a former botanical chemist at the University of Hawaii, stated that, "People are crazy about this plant. They use it for diabetes, high blood pressure, cancer, and many other illnesses"^[47]. Bushnell reported that Noni was a traditional remedy

used to treat broken bones, deep cuts, bruises, sores, and wounds^[48]. In addition, Polynesians are reported to have successfully used Noni to treat breast cancer and eye problems. Joseph Betz, a research chemist in the FDA's Division of Natural Products, Center for Food Safety and Applied Nutrition, stated that "*Morinda citrifolia* has been tested for a number of biological activities in animal and anti-microbial studies." He reports that the dried fruit has smooth muscle stimulatory activity and histaminergic effects. Research into the traditional uses of Noni indicate that it was the second most popular plant used in herbal remedies with approximately 40 known and recorded formulations (Table 4). Noni is included in the traditional pharmacopoeias of Native Hawaiians, other Pacific Islanders, and Asian populations. We enlisted the some traditional medicinal uses of different parts of noni plant in Table 2. Also, we described the health benefits (Table 3) and mechanisms of some noni phytochemicals.

CONCLUSION

Thus above studies of constituents and therapeutic applications indicate that Noni is having wide scope of activities and can better be called as Magic fruit. The study aids to excavate other applications of the fruit based on chemical constituents of fruit.

ACKNOWLEDGEMENT

Authors are thankful to Shri. G. D. Patil Secretary Shree Warana Vibhag Shikshan Mandal Warananagar for continuous support. Authors are thankful to Dr. JI Disouza Principal TKCP Warananagar, Mrs. Dr. U. S. Chougule, Admin Officer TKCP Warananagar and Mrs. S. S. Shinde Asst Prof. TKCP Warananagar.

REFERENCES

1. Zhu, Y.P., Woordongbag, H.J., 1995. Traditional Chinese herbal medicine. Pharm World Sci 17, 103-112.
2. Whistler, W.A., 1985. Traditional and herbal medicine in the cook islands. J Ethnopharm 13, 239-280.
3. Singh, Y., Tkahihifo, T., Panuvu, M., Slatter, C., 1984. folk medicine in tonga. A study on the use of herbal medicine for obstetric and gynecological conditions and disorders. J. Ethnopharm 12, 305-325.
4. Palu, A.K., Kim, A.H., West, B.J., Deng, S., Jensen, J., White, L., 2008. The effect of *Morinda Citrifolia* L. (Noni) on the immune system: its molecular mechanisms of action.. J Ethnopharmacol 115, 502-506.

5. Wang, M.Y., West, B.J., Jensen, C.J., Nowicki, D., Su, C., Palu, A.K., Anderson, G., 2002. *Morinda Citrifolia* L. (Noni): a literature review and recent advances in noni research. *Acta Pharmacol Sinic* 23(12), 1127-1141.
6. Eisenberg D.M, Davis R.B., Euncr S.L., Appel S, Wilkcy S, Van Rompay M, Kessler R.C., 1990-1997. Trends in alternative medicine use in United State. Results of a follow up national survey. *JAMA* 280, 1569-1575.
7. Cosyns J.P., Jadoul M, Squifflet J.P, Wese F.X., Van Y, Perscle do Strihou C. 1999,Urothelial lesions in Chincsc-herb nephropathy. *Am J Kidny Dis* 33, 1011-1017.
8. Wang, M.Y., West, B.J., Jensen, C.J., Nowicki, D., Su, C., Palu, A.K., Anderson, G., 2002. *Morinda Citrifolia* L. (Noni): a literature review and recent advances in noni research. *Acta Pharmacological Sinica* 12, 1127-1141.
9. www.Indian-noni.net/faq/faq.htno.
10. Swanholm CE, St John H, Scheuer PJ. 1959 A survey of alkaloids in Hawaiian plants. *Pacific Science* 13: 295-305.
11. W. M. Ying, B. J. WEST, C J. JENSEN, D. NOWICKI, S.U Chen, A. K.PALU, G. ANDERSON. *Morinda citrifolia* (Noni): A literature review and recent advances in Noni research. *Acta Pharmacol Sin* 2002 Dec; 23 (1 2): 1127 -1141.
12. Morton, J.F., 1992. The ocean-going Noni, or Indian mulberry (*Morinda citrifolia*, Rubiaceae) and some of its “colourful” relatives. *Economic Botany* 46, 241–256.
13. Elkins, R., 1998. Hawaiian Noni (*Morinda citrifolia*) Prize Herb of Hawaii and the South Pacific. Woodland Publishing, Utah.
14. Dixon, A.R., McMillen, H., Etkin, N.L., 1999. Ferment this: the transformation of Noni, a traditional Polynesian medicine (*Morinda citrifolia*, Rubiaceae). *Ecological Botony* 53, 51–68.
15. Ross, I.A., 2001. *Medical Plants of the World. Chemical Constituents, Traditional and Modern Medical Uses*. Humana Press, New Jersey
16. Cardon, D., 2003. *Le Monde des Teintures Naturelles*. Belin, Paris.
17. Dittmar, A., 1993. *Morinda citrifolia* L. Use in indigenous Samoan medicine. *Journal of Herbs, Spices and Medicine Plants* 1, 77–92.
18. Lu´ berck, W., Hannes, H., 2001. Noni. *El Valioso Tesoro Curativo de Los Mares del Sur*. Editorial EDAF S.A., Madrid.
19. Nelson, S.C., 2001. Noni cultivation in Hawaii. *Fruit and Nuts* 4, 1–4.

20. Nelson, S.C., 2003. Noni Cultivation and Production in Hawaii. In: Proceedings of the 2002 Hawaii Noni Conference. University of Hawaii at Nanao. College of Tropical Agriculture and Human Resources. Hawaii.
21. Chan-Blanco Y, Vaillant F, Perez MA, Reynes M, Brillouet JM, Brat P. The noni fruit (*Morinda citrifolia* L.): A review of agricultural research, nutritional and therapeutic properties. J Food Compos Anal 2006;9(6-7): 645-54.
22. Wang, M.Y., Su, C., 2001. Cancer preventive effect of *Morinda citrifolia* (Noni). Annals of the New York Academy of Sciences 952, 161–168.
23. Dittmar, A., 1993. *Morinda citrifolia* L. Use in indigenous Samoan medicine. Journal of Herbs, Spices and Medicine Plants 1, 77–92.
24. Heinicke, R.M., 1985. The pharmacologically active ingredient of Noni. Bulletin of the National Tropical Botanical Garden 15, 10–14.
25. Yanine Chan-Blancoa, Fabrice Vaillantb, Ana Mercedes Perezb, Max Reynesc, Jean-Marc Brillouetc, Pierre Bratc. The noni fruit (*Morinda citrifolia* L.): A review of agricultural research, nutritional and therapeutic properties. Journal of Food Composition and Analysis 19 (2006) 645–654.
26. Morton, J.F., 1992. The ocean-going Noni, or Indian mulberry (*Morinda citrifolia*, Rubiaceae) and some of its “colourful” relatives. Ecological Botany 46, 241–256.
27. SHOVIC, A.C., Whistler, W.A., 2001. Food sources of provitamin A and vitamin C in the American Pacific. Tropical Science 41, 199–202.
28. Dixon, A.R., McMillen, H., Etkin, N.L., 1999. Ferment this: the transformation of Noni, a traditional Polynesian medicine (*Morinda citrifolia*, Rubiaceae). Ecological Botany 53, 51–68.
29. Levand, O., Larson, H.O., 1979. Some chemical constituents of *Morinda citrifolia*. Planta Medica 36, 186–87.
30. Sang, S., Cheng, X., Zhu, N., Stark, R.E., Badmaev, V., Ghai, G., Rosen, R., Ho, C.T., 2001. Flavonol glycosides and novel iridoid glycoside from the leaves of *Morinda citrifolia*. Journal of Agriculture and Food Chemistry 49, 4478–4481.
31. Elkins, R., 1998. Hawaiian Noni (*Morinda citrifolia*) Prize Herb of Hawaii and the South Pacific. Woodland Publishing, Utah.
32. Ross, I.A., 2001. Medical Plants of the World. Chemical Constituents, Traditional and Modern Medical Uses. Humana Press, New Jersey.

33. Wang, M.Y., West, B., Jensen, C.J., Nowicki, D., Su, C., Palu, A.K., Anderson, G., 2002. *Morinda citrifolia* (Noni): a literature review and recent advances in Noni research. *Acta Pharmacologica Sinica*. 23, 1127–1141.
34. Wei Xiang, Qi-Shi Song, Hong-Jie Zhang, Shi-Ping Guov. Antimicrobial anthraquinones from *Morinda angustifolia*. *Fitoterapia* 79 (2008) 501–504.
35. Inoue, K., Nayeshiro, H., Inouye, H., Zenk, M., 1981. Anthraquinones in cell suspension culture of *Morinda citrifolia*. *Phytochemistry* 20, 1693–1700.
36. Sang, S., Wang, M., He, K., Liu, G., Dong, Z., Badmaev, V., Zheng, Q.Y., Ghai, G., Rosen, R.T., Ho, C.T., 2002. Chemical components in Noni fruits and leaves (*Morinda citrifolia* L.). In: Ho, C.T., Zheng, Q.Y. (Eds.), *Quality Management of Nutraceuticals*. ASC Symposium Series 803, American Chemistry Society, Washington, DC, pp. 134–150.
37. Shengmin Sang, Kan He, Guangming Liu, Nanqun Zhu, Mingfu Wang, Jin-woo Jhoo, Qunyi Zheng, Zigang Dong, Geetha Ghai, Robert T. Rosen and Chi-Tang Ho. Citrifolinin A, a new unusual iridoid with inhibition of Activator Protein-1 (AP-1) from the leaves of noni (*Morinda citrifolia* L.)
38. Shixin Deng, Brett J West, C Jaraka Jensen. Simultaneous characterization and quantitation of flavonol glycosides and aglycones in noni leaves using validated HPLC-Uv/MS method. *Food Chemistry*. 111, 526-529.
39. Liu, G., Bode, A., Ma, W.Y., Sang, S., Ho, C.T., Dong, Z., 2001. Two novel glycosides from the fruits of *Morinda citrifolia* (Noni) inhibit AP-1 transactivation and cell transformation in the mouse epidermal JB6 cell line. *Cancer Research* 61, 5749–5756.
40. McClatchey, W., 2002. From Polynesian healers to health food stores: changing perspectives of *Morinda citrifolia* (Rubiaceae). *Integral Cancer Therapy* 1, 110–120.
41. Farine, J.P., Legal, L., Moreteau, B., Le Quere, J.L., 1996. Volatile components of ripe fruits of *Morinda citrifolia* and their effects on *Drosophila*. *Phytochemistry* 41, 433–438.
42. Srivastava, M., Singh, J., 1993. A new anthraquinone glycoside from *Morinda citrifolia*. *Journal of Pharmacology* 31, 182–184.
43. Hirazumi, A., Furusawa, E., 1999. An immunomodulatory polysaccharide-rich substance from the fruit juice of *Morinda citrifolia* (Noni) with antitumour activity. *Phytotherapeutic Research*. 13, 380–387.
44. Anh Kim T. Bui a, Antony Bacic b, Filomena Pettolino. Polysaccharide composition of the fruit juice of *Morinda citrifolia* (Noni). *Phytochemistry* 67 (2006) 1271–1275

45. Solomon N. The tropical fruit with 101 medicinal uses, NONI juice. 2nd ed. Woodland Publishing; 1999.
46. Allen WH, London C. Some information on the ethnobotanical properties of Noni (*Morinda citrifolia*). In: The useful plants of india; 1873.
47. Abbott I A. The geographic origin of the plants most commonly used for medicine by Hawaiians. J Ethnopharmacol 1985; 14: 213-22.
48. Bushnell O A, Fukuda M, Makinodian T. The antibacterial properties of some plants found in Hawaii. Pacific Science 1950; 4: 167-83.
49. attmed.creighton.edu/noni/history.htm
50. Raj RK. Screening of indigenous plants for anthelmintic action against human *Ascaris Lumbricoides*: Part-II. Indian J Physiol Pharmacol 1975; 19: 47-9.
51. Hirazumi, A., Furusawa, E., 1999. An immunomodulatory polysaccharide-rich substance from the fruit juice of *Morinda citrifolia* (Noni) with antitumour activity. *Phytother. Res.* 13, 380–387.[51]
52. Pride Publishing, Noni: Polynesia's natural pharmacy. 1997. p 13. [52]
53. Moorthy NK, Reddy GS. Preliminary phytochemical and pharmacological study of *Morinda citrifolia*, Linn. *Antiseptic* 1970; 67: 167-71. [53]
54. J. Yang , R. Paulino, S. Janke-Stedronsky, F. Abawi Free-radical-scavenging activity and total phenols of noni (*Morinda citrifolia* L.) juice and powder in processing and storage [54]