AYUSHDHARA 2014;1(2):33-39

An International Journal of Research in AYUSH and Allied Systems

Review Article

GERIATRIC HEALTH CARE THROUGH NUTRACEUTICALS OF *MORINDA CITRIFOLIA* L.: A REVIEW

Soni Pradeep[1]*, Indoriya G S[2], Sharma Chakrapany[3], Parashar Rahul[4]

*[1]Medical Officer, Govt. Ayurveda Hospital, Udaipur, Rajasthan, India.

[2]Principal, M.M.M. Govt. Ayurveda College, Udaipur, Rajasthan, India.

[3]Professor & HOD, Department of Dravyaguna, Dr. Sarvepalli Radhakrishnan Rajasthan Ayurved University, Jodhpur, Rajasthan, India.

[4]Lecturer, Dept. of Swasthavritta, M.M.M. Govt. Ayurveda College, Udaipur, India.

Article info

Article History:
Received: 20-11-2014
Accepted: 19-12-2014

KEYWORDS: Ageing, *Jara*, *Morinda citrifolia* L., Nutraceuticals, Noni, proxeronine, xeronine, cancer prevention, antioxidants, selective COX-2 inhibitor.

***Corresponding Author**
Dr. Pradeep Soni
Medical Officer, Govt. Ayurveda Hospital, Intali (Mavli)
Udaipur (Raj.), India.
Email: drpradeepsoni@gmail.com
Mob: +919414758052

ABSTRACT

Ageing (*Jara*) is a natural process and an inevitable phenomenon in life. Ageing not only brings about a continued generalized involution of the biosystem, it also predisposes in aged individual to set of diseases and disorder warranting special medical care. Problems of geriatric age group health problems are joint problems, impairment of special senses, cardio vascular disease, hypothermia, cancer, prostate enlargement, diabetes & accidental falls psychological problems. Noni is the common name for *Morinda citrifolia* L and is also called Indian Mulberry. Morinda species has been described in *Ayurveda* as the name of *Akshiki phala, Ashyuka* and also used in folk remedies by traditionally for over 2000 years, and is reported to have a broad range of therapeutic effects, including antibacterial, antiviral, antifungal, antitumor, antihelmin, analgesic, hypotensive, anti-inflammatory, and immune enhancing effects. The aim of this study is to explore the importance of *Morinda citrifolia* to reveal the nutritional and medicinal value of the Noni plant, and to summarize scientific evidence that supports it geriatric health care through its neutraceuticals such as vit C, flavanoids, tannins and antioxidants.

INTRODUCTION

The population are elderly at present and it is expected to reach up 13.3% (1.2 billion) in 2025.[3] At present, India stands second to China in its elderly population with 7 per cent of Indian population belonging to the age group of 65 years and above and it is expected to rise to 10 per cent by 2030.NSSO data underlines that at any time almost 50% of elderly may be ill, and 75% of them have more than two diseases.[4] Geriatric age group have many health problem such as Joint problems, chronic inflammatory and degenerative conditions such as Arthritis, Osteoporosis, Impairment of special senses, Cardio vascular disease, Hypothermia, Cancer, Prostate enlargement, Diabetes, Psychological problems, Alzheimer's disease, Depression, Parkinson's disease and age related urinary problems. A study shows that presently in India elder people, geriatric aged, suffered by Cataract & Visual impairment- 88%, Arthritis & locomotion disorder- 40%, CVD & HT- 18%, Neurological problems- 18%, Respiratory problems including Chronic bronchitis- 16%, GIT problems- 9%, Psychiatric problems- 9%, Loss of Hearing - 8%.[5]

Morinda citrifolia L (Noni) (figure 1) belongs to Rubiaceae family, a small evergreen tree 3-10 m in height; bright green and elliptical leaves, white tubular flowers and ovoid 'grenade like' yellowish white fleshy fruit 5-10cm long has a lumpy surface covered by polygonal shaped section, triangular and reddish brown seeds and fruit has a foul taste and odour.[6]

Figure 1: Image of *Morinda citrifolia* L.

Morinda citrifolia L. is also known as Indian mulberry and has been used in folk remedies by Polynesians for over 2000 years[7]. The plant is mentioned in *Ayurved* as *Achuka*, which means longevity, and was used as a balancing agent and and *Charak* described it as *Akshiki phala or Ashyuka*.[8] This is known as other vernacular name in Indian such as Aal in Hindi, *Achuk, Akshi Phal* and Ranjandru in Sanskrit, Bartondi and Surangi in Marathi, Sarogi in Gujarati and Numaakai in Tamil language.[9]

Noni is used for various traditional (Table 1) treatments for malaria, general febrifuge, and analgesic, laxative, jaundice (decoction of bark), hypertension, ulcers, rheumatism, and sore throat. Fruit is believed to be as an appetite and brain stimulant. It has been reported to have a broad range of health benefits for cancer, infection, arthritis, diabetes, asthma.[10] Ayurveda adds that noni is a *Kapha* stabilizer and helps to remove excess *Pitta* (fire element) from the body.[8] There is an impressive list of body systems which "have all been effectively influenced by noni circulatory, digestive, respiratory, integumentary (skin), endocrine, immune, nervous, skeletal system. In Indian system of medicine, leaves and roots are used as astringent, deobsterent, emmengogue and to relieve pain in the gout[11]. It is tonic, antipyretic, regularize menses and useful in dysentery. Root is purgative, Leaves are used for infantile diarrhea, dysentery, to heal the wounds, ulcers and the pain of gout. Poultice of leaves is used in wound healing, charred unripe fruits mixed with salt relieve diseased gums.[9]

Table 1: Traditional uses of *M. citrifolia* L.[45,47,48,49]

Plant part	Traditional uses
Leaves[47,48]	Chest relieves coughs, nausea, colic (Malaysia); juice of the leaves is taken for arthritis (Philippines); hypertension, fever, stomach ache, fractures, diabetes, loss of appetite, urinary tract ailments, abdominal swelling, hernias, stings from stonefish, and human vitamin A deficiency (Micronesia)
Bark[45,47]	Laxative, jaundice, eye problems, skin wounds and abscesses, gum and throat problems, respiratory ailments, constipation, fever (Pacific Islands, Hawaii). Root bark is useful in hypertension, osteodynia and lumbago.
Fruits[47,48,49]	lumbago, sore throat, asthma and dysentery (Indochina); pounded unripe fruit is mixed with salt and applied to cuts and broken bones; ripe fruit is used to draw out pus from an infected boil (Hawaii); juices of over-ripe fruits are taken to regulate menstrual flow, intestinal worms, ease urinary problems (Malay); fruits used to make a shampoo (Malay, Hawaii) and to treat head lice (Hawaii).
Flowers[45]	Dysentery, hypertension, eye diseases.

Any medicinal property exhibits by a plant is due to the presence of secondary metabolites in a plant. It has been reported to have a broad range of therapeutic and nutritional value due to major components as scopletin, octoanoic acid, potassium, Vit. C, Vit. B3, Vit. A, anthraquinones such as nordamnacanthal (cancer version compound), morindone; β-sitosterol and putative proxeronine etc.[12] Detailed chemical constitution of *M. citrifolia* and their effects is given in Table 2.

Table 2: Chemical constitutions of *M. citrifolia* L. and their effects [12]

Part in which present	Type of chemical	Active principles	Effects of compounds
Fruits and fruit juice	Alkaloids (Tikta-Bitter principle)	Xeronine	It enhances enzyme activity and protein structure
	Polysaccharides	Glucuronic acid, Galactose, Arabinose, Rhamose	Immune-stimulatory, immune-modulatory, anti-bacterial, anti-tumor and anti-cancer
	Scopoletin		Dilates vasculature and lowering blood pressure, anti-fungal, anti-inflammatory, analgesic, anti-histamine, sleep disorders, arthritic conditions, migraine and Alzheimer's disease.
	Vitamins and Minerals	Vit. C, vit. E, vit. A, vit. B3, Mg, Fe, K, Selenium, Zn, Cu	Wound healing, premature of graying hair and useful for health.
Leaves	Glycosides	Flavonol, Iridoid, Citrifolinoside	Anti-cancer effects (DPPH free radical scavenging activity inhibition of UVB-induced Activator Protein-1 activity in cell cultures)
Roots	Anthraquinones	Damnacanthal	Antiseptic and anti-bacterial effect

			(Staphylococcus, Shingela and Salmonella), inhibiting formation of lung carcinoma in mice
	Morindin and Morindone		Dyes and anti-bacterial.

Method of data collection

Details of articles, books and internet related to nutraceutical efficacy of *Morinda citrifolia* in health care are reviewed. Here, an attempt has been made to gathered those scattered reporting from various published research articles and books related to preventive and curative health care regarding to geriatric.

BIOLOGICAL ACTIVITY

Anti-inflammatory activity

Over 40% people are suffered by the arthritis in the age of 50-60 year. Research showed that an enzyme responsible for pain and inflammation protect the gastric and kidney and produce a prostaglandin. NSAIDs drugs like ibuprofen or other pain killer inhibits COX-2 enzyme with COX-1 resulting to produce such as gastritis and colitis ailments. The main target of NSAIDs activity is the cyclooxygenase (COX) enzyme. Two isoforms of COX have been identified; COX-1, the constitutive isoform and COX-2, the inducible form of the enzyme.[13] Accumulating evidence indicates that COX-2 inhibitors may be involved in breast, colon and lung cancer development. COX-2 can undergo rapid induction in response to chemical carcinogens. It has been suggested that COX-2 overexpression may lead to increased angiogenesis and inflammatory reaction.[14] Therefore the inhibition of COX-2 might have a general cancer preventive effect via anti- inflammatory activity and decrease angiogenesis. The inhibition of *Morinda* fruit juice on COX-2 and COX-1 activities was compared with traditional NSAIDs such Aspirin and COX-1 and COX-2 activities were determined based upon the PGE2 levels generated during the incubations of human plates with tested compounds and/or vehicle by the Amershan ELA assay.[15] The study shows that COX-2 inhibition is very significant of *Morinda* fruit juice without side effect and scientific evidence for a strong anti-inflammatory activity in its juice and may also be cancer prevention.[16] The study shows that Noni inhibits COX-2 enzyme without interrupting COX-1 work and consequently relief in arthritis.

Antidiabitic activity

Free radicals are continuously produced in the body as a result of normal metabolic processes and interaction with environmental stimuli. Oxidative stress results from and imbalance between radical generating and radical scavenging systems that has increased free radical production or reduced activity of antioxidant defenses or both. Implication of oxidative stress in the pathogenesis of diabetes mellitus (DM) is suggested not only by oxygen free radical generation but also due to non-enzyme protein glycosylation; auto-oxidation of glucose, impaired glutathione metabolism, alteration in antioxidant enzymes and formation of lipid peroxidase.[17-18] Many of complications of DM, including atherosclerotic vascular disease, retinopathy, and the leading cause of mortality in DM have been linked to oxidative stress and antioxidants have been considered as treatment of DM.[19]

The components are identified in the *Morinda* plant such as octoanic acid, K, vit.C, terpenoids, scopoletin, flavones glycosides, lineoleic acid, anthraquinones, morindone, rubiadin and alizarin. [20] Plants contains substantial amount of antioxidants, flavonoids and tannins have hypoglycemic effect on DM. [21]

Administration of *Morinda citrifolia* juice decreases the level of tissue lipid per oxidation and hydroperoxides to normal level. The hypoglycemic action of *Morinda citrifolia* may bring about to stimulation of surviving β-cells of islets of Langerhans to release more insulin. Numerous studies have revealed lowered antioxidant and enhanced peroxidative status in DM.

The study exhibits that *Morinda citrifolia* could be a supplement as an antioxidant therapy and may be beneficial of correcting the hyperglycaemia and preventing diabetic complications due to lipid peroxidation and free radicals. The fruit of *Morinda citrifolia* is not only similar to insulin in having a hypoglycemic effect and also controls the blood glucose level, improving the lipid metabolism and prevents diabetic complications from lipid peroxidation and antioxidant system and could be useful for preventing or early treatment of diabetic mellitus.

Anti-tubercular effect

Saludes and colleagues from the Philippines reported that *Morinda citrifolia* leaf extract has been found effective to 90% killed Mycobacterium tuberculosis bacteria in a test tube in the comparison as a leading anit-tubercular medicine, Rifampcin, which has an inhibition rate of 97% at same concentration. [22]

It has been widely observed and accepted that the medicinal value of plants lies in the bioactive phytocomponents present in the plants. Many plants, one of *Morinda citrifolia* and their extracts are used against microbial infection due to the presence of secondary metabolites such as phenol, essential oil, terpenoids, and flavonoids.

Anthelmintic effect

An ethanolic extract of tender leaves of *Morinda citrifolia* induced paralysis and death of the human parasitic nematode worm, *Ascaris lumbricoides* within a day.[23] Mortan, a botanist, reported that

Morinda citrifolia has been used in the Philippines and Hawaii as an effective insecticide. [24]

Anti-bacterial effect

Morinda citrifolia fruit exhibits its antibacterial activity due to acubin, L-asperuloside, alizarin as well as some other anthraquinone compounds in root. These components have been shown to fight against infectious bacteria such as *Pseudomonas aerugnosa*, *Proteus morgaii*, *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Salmonella* and *Shigela*, *Klebsiella*, *Proteus vulgaris*. The antibacterial components of *Morinda citrifolia* are responsible for the treatment of skin infection, cold, fever, and other bacterial caused health problems.[25] Locher reported that Polynesian used *Morinda citrifolia* for the treatment of infectious disease in their traditional medicinal.[26] Bushnell reported that *Morinda citrifolia* was used traditionally for broken bones, deep cuts, bruises, sores and wounds.[27] Newly research signified that scopoletin, a health promoter, inhibits the activity of *E. coli* and also helps stomach ulcer by the inhibition of the bacteria *H.pylori*. [28]

Antitumor activity

Hirazumi, a researcher at the University of Hawii, in 1992, reported anticancer activity from the alcohol precipitate of Noni fruit juice on lung cancer in C57 B1/6 mice at the 83th annual meeting of American Association for Cancer Research. It was concluded that the Noni fruit juice seems to suppress tumor growth indirectly by stimulating the immune system. [29]

Damnacanthal, an antthraquinone compound, isolated from *Morinda citrifolia* root, is an inhibitor of Ras, a oncogene is believed to be associated with the signal transduction in several human cancers such as lung, colon, pancreas, and leukamia[30] and Hiwasa reported to have a potent inhibitory activity towards tyrosine kinase such as Lck, Src, Lyn and EGF receptors. He examined the effect of damnacanthal on UV ray induced apoptosis in ultraviolet resistant human UVr-1 cells. [31]

Hypotensive activity

Dang Van Ho of Vietnam reported that a total extracts of *Morinda citrifolia* root has a hypotensive effect **[32]** and Moorthy reported that ethanol extract of *Morinda citrifolia* showed the lowering blood pressure.**[33]** Asahina, Hawaiin physician reported, fruit juice have a diuretic property resulting to control blood pressure.[34]

The Polynesians utilized this plant in the treatment of high blood pressure as herbal remedies. Scientific evidence also proved its hypotensive effect (Abbott, 1985; Dixon *et al.,* 1999). The chemical compound, scopoletin, dilates the blood vessels and reduced the hardness of arteries and vessels and after all lowered blood pressure.

Antiviral activity

A compound, 1-methoxy-2-formyl-3-hydroxyanthraquinone, detected from root suppressed the cytopathic effect of HIV infected MT-4 cells, without inhibiting cell growth.[35]

Anti-ageing effect

Wang *et al*. (2002) observed that the thymus in animals treated with TNJ was enlarged. The wet weight of the thymus was 1.7 times that of control animals at the seventh day after drinking 10% TNJ in drinking water. The thymus is an important immune organ in the body, which generates T cells, involved in the ageing process and cellular immune functions. TNJ may enhance immune response by stimulating thymus growth, and thus affecting anti-ageing and anticancer activities, and protecting people from other degenerative diseases.[36]

Immunological effect

Asahina et al found that an alcohol extract of fruit juice of *Morinda citrifolia* inhibited the production of tumor necrosis factor - α (TNF- α), which is an endogenous tumor promoter. Therefore the alcohol extract may inhibit the tumor promoting effect of TNF-α.[37]

Noni-ppt contains a polysaccharide-rich substance that inhibited toxic effects in adapted cultures of lung cancer cells, but could activate peritoneal exudates cells to impart profound toxicity when co-cultured with the tumor cells. This suggested the possibility that Noni-ppt may suppress tumor growth throughout the activation of host immune system. Noni-ppt was also capable of stimulating the release of several mediator from murine effector cells, including TNF-α, interleukin-1 beta (IL-1β), IL-10, IL-12, interferon-gamma (IFN-γ) and nitric oxide (NO). [38]

Antioxidant activity

In general consuming fruits and vegetables reduces free radicals-induced oxidative damage and the consequent lipid peroxidation and therefore reduce the cancer risk. It is believed that fruits and vegetables are major sources for antioxidants. Noni is a medicinal plant that helps the human in different health conditions. It was believed that the Noni fruit juice contained significant level of antioxidants. This has been proved scientifically by the analysis of TNJ. The study was designed to measure how the TNJ scavenged super oxide anion radicals (SAR) and quenched lipid peroxides (LPO) by TNB assay and LMB assay, respectively. [39-40] SAR scavenging activity was examined in vitro by *Tettrazolium nitroblue* (TNB) assay. The SAR scavenging activity of TNJ was compared to that of three known antioxidants; vitamins C, grape seed powder, and pyncogenol at the daily dose per serving level recommended by US RDA's or manufacturer's recommendations. Under the experimental conditions the SAR scavenging activity of TNJ was shown to be 2.8 times that of vitamin C, 1.4

times that of pyncogenol and 1.1 times that of grape seed powder. Therefore TNJ has a great potential to scavenge reactive oxygen free radicals. [41-42]

Cigarette smoking has been implicated in the pathogenesis of emphysema, ischemic heart disease and cancer. There are 48 known chemical carcinogen among the 4000 compounds detected in cigarettes. Recently, it was reported that 227 possible carcinogen exist in cigarettes. It was estimated that some 1×10^{17} oxidant molecules are present in each puff of cigarette smoke.[43] These free radicals are cause to oxidative damage and consequent lipid peroxidation which are responsible for the human disease. It is hypothesized that antioxidant of fruit juice of NONI may protect individual from cigarette smoke by scavenging oxygen free radicals and quenching lipid peroxides. Therefore it may be beneficial for the prevention of heart, lung and brain disease as well as delaying the ageing processing and maintaining overall good health.

DISCUSSION

The nutritive and medicinal importance of *Morinda citrifolia* is established as scientifically and traditionally. Research study around the world has gained its nutraceuticals. All the medicinal activity is performed by these phytochemicals; neutraceuticals, which shows the various effects.

Proxeronine is a natural precursor for xeronine, found in fruit. Proxeronine is converted to alkaloid, xeronine, in the body by enzyme proxerokinase. Xeronine is able to modify the molecular structure of proteins. Thus xeronine has a wide range of biological activities. This alkaloid is a critical normal metabolic coregulator. Xeronine stimulate the brain cells and regulate the work system of endorphin hormone. This is also helpful in the high blood pressure, menstrual cramps, arthritis, gastric ulcers, sprains, injuries, mental depression, senility, poor digestion, drug addiction and pain[44].

Scopoletin conjugate with pituitary hormone serotonin and regulate the body temperature and control hunger, thirst and emotions. This is helpful in sound sleeping and mentally impulses. And also reduce blood pressure, anti-inflammatory, anti-histamin, antibacterial properties.[12] Demnacanthal have a potent inhibitory activity for tyrosine kinase and have antitumor activity and inhibits growth of pre-cancerous cells. [12,45]

Glycosides are useful for cardiotonic. Glycoside, citrifolinoside, has been shown to have an inhibiting effect on AP-1 transactivation and cell transformation in the mouse epidermal JB6 cell line. **[46]**

Anthraquinone compounds are antibacterial agents. So it is used for infectious diseases such as skin infection, colds, fever, wounds and other bacterial health problems and also prevents from various allergies. It prompts the digestive secretions of the stomach and small intestines, stimulates bile flow and promote the activity of the entire digestive process. **[45]**

Morinda is rich in amino acids, which are the building blocks for proteins and are important for most body functions. The essential amino acids are the ones our bodies cannot make and we therefore must get these from our diet because they maintain healthy skin, nerve cells, heart tissues, blood vessels, help balance mood and keep cell membranes working properly and efficiently by improving the nutrient- toxin exchange. Morinda contains 17 of the 20 known amino acids, including all 9 essential amino acids. **[45]** Sterols help to regulate the blood circulation, prevent the deposition of substances like cholesterol in the arteries of heart. Thus prevent the cardiac problems.

Terpenenoids and flavonoids are highly antioxidant components and enhance the immunity power. Selenium is another substance for immunity.

Fibres regulates the bowl moments, purify the blood, lowering LDL cholesterol and helpful for maintain blood sugar.

Thus the nutraceuticals; phytochemicals, of *Morinda citrifolia* L. supports the immune system's natural ability to fight diseases and infection. Circulatory system, tissues, and cells: *Morinda citrifolia* L. is one of the best antioxidants that help the body get rid of harmful free radicals. It also increases energy levels.

CONCLUSION

The nutritive and medicinal value of the *Morinda citrifolia* has been clearly established with the research outcome that was completed in different laboratories in world. Hopefully furthermore useful and vital information will be emerged out of the research activities initiated on this wonder tree, Noni. Since the already published literature of various animal studies and clinical trials has clearly proved beyond doubt for its medicinal importance and nutritional significance, it will be in the limelight in both researches as well as in alternative medical arena in the coming days.

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Cite this article as:
Soni Pradeep, Indoriya GS, Sharma Chakrapany, Parashar Rahul. Geriatric Health Care Through Nutraceuticals of Morinda Citrifolia L.: A Review. AYUSHDHARA, 2014;1(2):33-39
Source of support: Nil, Conflict of interest: None Declared