



# **Role of the Plant *Morinda citrifolia* L. in Management of Diseases in Fish Cultured: A Mini-review**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

Production failure in fish farming activities, one of which is caused by disease. So the prevention of disease needs to be done by using environment friendly technology. Disease control efforts can be carried out through preventive and curative measures. Preventive measures can be taken by increasing the immunity of fish. The use of herbal ingredients is relatively safe for fish and the environment to be used as a source of drugs or immunostimulants. *Morinda citrifolia* is one of the medicinal plants that contains various types of active ingredients that are antibacterial and immunostimulant, including alkaloids, flavonoids, tannins, saponins, steroids, phenols and terpenoids, glycosides, carbohydrates, coumarine and scopoletin. Therefore, *M. citrifolia*, both the fruit and the leaves, can be used for treatment and prevention of diseases that attack cultured fish. The purpose of writing this article is to describe several research results that prove the ability of parts of the noni plant, namely the leaves and fruit to be used as drugs or immunostimulants as an effort to control diseases in cultured fish. Several studies have shown that noni plays a role in overcoming diseases that infect cultured fish, both for treatment and prevention. The parts of *M. citrifolia* plant used are the leaves and fruit in various dosage forms, namely extract, flour and juice. The types of diseases that can be cured are bacterial diseases caused by *Aeromonas hydrophila*

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that infect *Leptobarbus hoevenii*, *Cyprinus carpio*, *Barbonymus gonionotus*, *Carassius auratus* and *Oreochromis niloticus* fish and parasitic diseases caused by *Argulus* sp., *Lernaea* sp. and *Trichodina* sp. Several types of fish, namely *Cyprinus carpio*, *Oreochromis niloticus* and *Penaeus monodon* increased body resistance after being treated with *M. citrifolia*, which was indicated by an increase in the number of leukocytes, an increase in total phagocytic activity and high survival after being challenged with pathogenic organisms.

**Keywords:** *Morinda citrifolia*; fish; disease; treatment; prevention.

## 1. INTRODUCTION

One of the supporting components of economic development that needs to be continuously increased in production is the aquaculture sector, whether it is done traditionally, semi-intensively or intensively. However, many obstacles are faced, one of which is the presence of disease attacks, which are caused by bacteria, viruses or fungi which result in production failure and significant losses. Therefore, disease prevention efforts need to be carried out through preventive and curative measures by optimally utilizing natural resources and using environmentally friendly technology. Herbal ingredients are one of the natural resources that can be used as an effort to control diseases that attack cultured fish which are quite effective and environmentally friendly. *Morinda citrifolia* noni is one of the drugs that has been widely used to treat various diseases in humans, including diabetes [1,2], arthritis [3], hypertension, heart disease, relieve indigestion, headache and fever [4]. Recent research results reveal that noni can be used as a tumor and cancer drug [5]. The use of noni as a treatment, prevention, and treatment of disease causes this commodity to be in great demand by the public [6]. Consumption of noni leaves and fruit as medicine can be in the form of fresh or processed products. Processed noni products in the form of juice, fruit extract in capsules, and other processed noni products have been exported to several countries such as Malaysia, Singapore, several Middle Eastern countries, and Europe. The development of processed noni products also extends to the cosmetic industry [7]. The use of *M. citrifolia* as a medicine is based on the phytochemical compounds it contains. *M. citrifolia* fruit contains phytochemical compounds as antibacterial, including acubin, L. asperuloside, alizarin and some anthraquinone substances [8,9,10]. Antibacterial substances contained in noni fruit have been shown to be able to fight several types of infectious bacteria, including *Pseudomonas aeruginosa*, *Proteus morgani*, *Staphylococcus aureus*, *Bacillus subtilis* and *Escherichia coli* [8]. Apart from being

antibacterial, the active ingredients contained in *M. citrifolia* have potential as antifungal agents [10,11]. *M. citrifolia* can also be used as an immunostimulant that can increase the body's resistance to disease [12]. This is based on the content of ascorbic acid contained in noni fruit as a source of vitamin C. In addition, *M. citrifolia* contains caproic acid, caprylic acid and capric acid including fatty acids. *M. citrifolia* fruit also contains alkaloids and flavonoids [13], while the leaves contain flavonoid compounds, saponins, steroids, alkaloids, vitamins and ascorbic acid [14]. An important alkaloid contained in the noni fruit is xeronine, which functions to activate enzymes and regulate protein function in cells [8]. Flavonoid compounds can function as antioxidants, antibacterial, immunomodulatory, and anti-inflammatory [15].

Based on the content of phytochemical compounds and the pharmacological properties of *M. citrifolia*, the purpose of this article is to prove the role of *M. citrifolia* plant for disease control in cultured fish for both treatment and disease prevention.

## 2. MORPHOLOGY AND CLASSIFICATION OF *Morinda citrifolia* L.

*Morinda citrifolia* L. is a tropical and wild plant, it can grow on the coast to an altitude of 1500 m above sea level, both on fertile and marginal land. Its distribution is quite wide, covering all the islands of the South Pacific, Malaysia, Indonesia, Taiwan, the Philippines, Vietnam, India, Africa, and the West Indies [16]. *M. citrifolia* plant height reaches 3-8 meters, the stems are branched with brown bark. This plant bears fruit throughout the year, the size and shape of the fruit varies, the length is about 5-10 cm, the fruit surface is uneven, mottled and warty. The young fruit is green, the more ripe it is white, yellow and transparent. Ripe fruit flesh is soft, juicy and smells bad. Fruits generally contain many seeds, in one fruit there are >300 seeds, but there are also noni types that have few seeds. Seeds are generally elongated flattened oval, brown to

black in color, wrapped by a layer or seed bag, so that they have a long shelf life and high growth power. The petiole is dark green, the leaves are crossed, facing each other. Leaf shape in general is almost round, oblong to oblong, glossy green leaf color, slightly rough wavy leaf surface. The base of the leaf is blunt-pointed and the tip of the leaf is pointed. Leaves 10–40 cm long and 5–17 cm wide. The flowers are bulb-shaped, coming out of the leaf axils [17].

*Morinda citrifolia* L. (Fig. 1) belongs to the Rubiaceae family, is a polynesian plant that grows a lot in Southeast Asia [12]. According to Djauhariya [14] the classification of *M. citrifolia* is as follows:

Kingdom : Plantae  
Phylum : Spermatophyta  
Class : Magnoliopsida  
Ordo : Rubiales  
Family : Rubiaceae  
Genus : *Morinda*  
Species : *Morinda citrifolia* L.



Fig. 1. *Morinda citrifolia* L.

### 3. TYPES OF DISEASES IN CULTURED FISH

Many types of diseases that attack fishery commodities, including freshwater fish that are cultivated, are from bacteria, viruses and fungi. Many types of bacterial diseases that infect freshwater fish, but there are some with more frequent infections, including motile aeromonas septicemia (MAS) caused by *Aeromonas hydrophila*, Edwardsiellosis caused by *Edwardsiella tarda*, columnaris caused by *Flexibacter columnaris*, Streptococcosis caused by *Streptococcus agalactinae* and *S. innae* [18,19]. There are not many types of viral diseases that infect freshwater fish, namely KHV

(koi herpes virus) infecting koi and carp (*Cyprinus carpio*). Meanwhile, viral diseases that infect other fishery commodities include WSSV (white spot syndrome virus) which infects *Penaeus monodon* shrimp, TSV (taura syndrome virus) infects white shrimp (*Litopenaeus vannamei*) and VNN (viral nervous necrosis) which infects grouper (*Epinephelus* spp.) and snapper (*Lates calcarifer*) [20]. The common fungal disease that attacks cultured fish is *Saprolegnia* sp. and *Achlya* sp. These two types of fungi in addition to infecting fish can also infect more fish eggs, especially unfertilized eggs. The attack of the fungus *Saprolegnia* sp. as the cause of Saprolegniasis disease is an obstacle in cultivation activities, because it can reduce the degree of hatching of eggs [21]. Various types of freshwater fish can be attacked by the fungus *Saprolegnia* sp., including *Oreochromis nilotica*, *Cyprinus carpio*, *Barbonymus gonionotus*, *Carassius auratus* and ornamental fish, especially at the fry and egg stages [22]. Parasitic diseases that often attack cultured fish include *Argulus* sp., *Trichodina* sp., *Myxobolus* sp., *Lernea* sp. *Ichthyophthirius multifiliis*. These types of parasites in high attack intensity can kill fish, especially on the size of the fry.

### 4. APPLICATION OF *Morinda citrifolia* L. FOR THE TREATMENT OF FISH DISEASES

Several studies have proven that *M. citrifolia* can be used to treat fish infected with disease. It has been reported that jelawat fish (*Leptobarbus hoevenii*) infected with *A. hydrophila* recovered after being treated with noni leaf extract administered through feed. The dose of 5 g/kg feed was the best dose, seen from the faster healing process and significantly resulted in the highest survival (79.17%) compared to other treatments [23]. The 96% ethanol extract of noni leaves can also treat koi fish (*Cyprinus carpio*) infected with *A. hydrophila* through immersion for 24 hours. Concentration of 800 ppm produces the least histopathological damage, which indicates that the fish are recovering from the attack of *A. hydrophila* bacteria. histopathological damage to the gills at these concentrations was hyperplasia 1.9%, fusion 1.6% and necrosis 1.2% [24]. In addition to the leaves, the fruit can also be used to treat fish infected by pathogenic bacteria. *Barbonymus gonionotus* fish infected with *A. hydrophila* bacteria experience healing after treatment with noni fruit extract through immersion for 20 minutes concentration of 15,000 ppm resulted in the fastest healing

process and the highest survival, which was 70% [25] (Table 1).

Several studies have shown that the noni plant is not only able to treat bacterial diseases in fish, it can also treat parasitic diseases in fish. From the results of research that has been done *M. citrifolia* fruit juice is effective for treating koi fish (*Cyprinus carpio* L.) infected by the parasite *Myxobolus* sp. by immersion for 7 hours. The dose of *M. citrifolia* fruit juice as much as 1-2% significantly ( $p > 0.001$ ) experienced a decrease in the degree of *Myxobolus* sp. the largest compared to the control [26]. *M. citrifolia* fruit juice solution also at a concentration of 4% can release *Lernaea* sp. from the body of *Carassius auratus* fish by soaking for 60 minutes, but cannot be used to kill *Lernaea* sp. [27] Rohmatullah]. Another study showed that argulosis in fish, which is caused by argulus ectoparasites, can be cured by using ethanol extract of *Citrifolia* fruit. The dose of 2 drops/L has been able to release *Argulus* sp. from the body of the comet fish (*Carassius auratus*) through immersion for 2 days, resulting in 100% survival [28]. The leaves of the noni plant can also treat parasitic diseases in fish. *Citrifolia* leaf solution boiled at a concentration of 750 ppm was able to reduce the intensity of *Trichodina* sp. which infects *Oreochromis niloticus* fish fry by soaking for 5 minutes [29].

In Table 1 it can be seen that the parts of the noni plant that can be used for treatment are the leaves and fruit, in various preparations, namely extracts, juices and decoctions. There is no standard dose for treatment depending on the type of fish, dosage form and the type of disease-causing pathogenic organism. The ability of the *M. citrifolia* plant for treatment, both as antibacterial and antiparasitic, because the noni leaf contains several secondary metabolites, including Alkaloids, Saponins, Tannins, Steroids, Flavonoids, Polyphenols, Triterpenoids and Quinones that function as antibacterial [30]. *M. citrifolia* fruit in addition to containing secondary metabolites, also contains bioactives namely scopoletin, octoanoic acid, potassium, vitamin C, anthraquinone, -sitosterol, carotene, vitamin A, flavonoid glycosides, linoleic acid, alizarin, amino acid, acubin, L-asperuloside, caproic acid, caprylic acid, ursolic acid, rutin, pro-xeronine and terpenoids [31]. These bioactive compounds have therapeutic effects, namely as analgesics, antimicrobials, antioxidants,

anticancer, anti-inflammatory and immunostimulants [32]. The mechanism of action of several secondary metabolites as antibacterial, including saponins by interfering with the permeability of bacterial cell membranes which causes cell membrane damage and causes the release of various important components from the bacterial cell, namely proteins, nucleic acids and nucleotides [33]. Tannins are one type of compound that belongs to the polyphenol group. Tannins including polyphenols can shrink bacterial cell walls, resulting in impaired cell permeability and impaired bacterial metabolism and eventually bacteria die [34]. peptidoglycan in bacterial cells and causes the bacterial cell wall layer to not form intact and can cause cell death [35] The mechanism of phenol as an antibacterial is by denaturing and coagulating proteins [33]. The mechanism of action of quinones as an antibacterial is by forming irreversible complex compounds with nucleophilic amino acid residues on transmembrane proteins found in plasma membranes, cell wall polypeptides, and enzymes found on the surface of cell membranes, thereby disrupting the life of bacterial cells [36].

## 5. APPLICATION OF *Morinda citrifolia* L. AS IMMUNOSTIMULANT

It has been reported that noni can be used as an immunostimulant that can increase the body's resistance to disease. One indicator of an increase in the body is an increase in the total number of leukocytes. The results of research that have been carried out prove that noni leaf extract given through feed can significantly increase the body resistance of carp (*Cyprinus carpio*) ( $P < 0.05$ ). The dose of 10 g/kg of feed was the best dose to increase the body's resistance of carp given for 28 days, indicated by an increase in leukocyte levels by 54.55% higher than the control [37]. In addition to leaf extract, noni fruit water extract can also increase the body's resistance of fish. Tilapia soaked in noni fruit extract solution for 96 hours experienced an increase in the total number of leukocytes. Concentration of 5400 ppm is the best concentration in increasing the resistance of tilapia with a leukocyte count of  $10.65 \pm 0.02$  ( $\times 10^4$  cells/mm<sup>3</sup>) [38]. Noni flour at a dose of 6 g/kg of feed given to *Oreochromis niloticus* for 45 days had the highest resistance to *Streptococcus iniae*, which was indicated by an increase in total

**Table 1. Application of *Morinda citrifolia* for the treatment of diseases in several types of fish**

<b>Type of fish</b>	<b>Type of Pathogen</b>	<b>Treatment</b>	<b>Result</b>	<b>Reference</b>
<i>Leptobarbus hoevenii</i>	<i>Aeromonas hydrophila</i>	Provision of <i>M. citrifolia</i> leaf extract through feed.	The dose is 5 g/kg of feed. fish experienced recovery with the highest survival (79.17%) compared to other treatments	[23]
<i>Cyprinus carpio</i>	<i>Aeromonas hydrophila</i>	Immersion in a solution of 96% ethanol extract of <i>M. citrifolia</i> leaves for 24 hours	At a concentration of 800 ppm the fish underwent healing characterized by mild histopathological damage, with a score of 1.9% hyperplasia, 1.6% fusion and 1.2% necrosis.	[24]
<i>Barbonymus gonionotus</i>	<i>Aeromonas hydrophila</i>	Immersion in <i>M. citrifolia</i> fruit extract for 20 minutes	At concentration of 15,000 ppm of fish was cured, resulting in the highest survival (70%).	[25]
<i>Carassius auratus</i>	<i>Argulus</i> sp.	Immersion in <i>M. citrifolia</i> fruit ethanol extract solution for 2 days.	A dose of 2 drops/L was able to release <i>Argulus</i> sp. from the body of <i>Carassius auratus</i> , resulting in 100% survival.	[28]
<i>Cyprinus carpio</i> L	<i>Myxobolus</i> sp.	Immersion in <i>M. citrifolia</i> juice solution for 7 hours.	Doses of 1-2% significantly ( $p > 0.001$ ) experienced a decrease in the degree of infection of <i>Myxobolus</i> sp. the largest compared to the control	[26]
<i>Carassius auratus</i>	<i>Lernaea</i> sp.	Immersion in a solution of <i>M. citrifolia</i> fruit juice ( <i>Morinda citrifolia</i> ) for 60 minutes.	Concentration of 4% <i>Lernaea</i> sp. separated from the body of the fish.	[27]
<i>Oreochromis niloticus</i>	<i>Trichodina</i> sp.	Immersion in a solution of <i>M. citrifolia</i> leaves boiled for 5 minutes	At a concentration of 750 ppm was able to reduce the intensity of the attack of the parasite <i>Trichodina</i> sp. up to 92.7%.	[29]

**Table 2. Application of *Morinda citrifolia* as immunostimulant**

Type of fish	Treatment	Result	Reference
<i>Cyprinus carpio</i>	Provision of noni leaf extract through feed for 28 days.	The dose of 10 g/kg feed can increase leukocyte levels by 54.55% higher than the control	[37]
<i>Oreochromis niloticus</i>	Immersion in <i>M. citrifolia</i> fruit water extract solution for 96 hours.	Concentration of 5400 ppm leukocyte count increased from $8.06 \pm 0.01$ to $10.65 \pm 0.02$ ( $\times 10^4$ cells/mm <sup>3</sup> ).	[38]
<i>Oreochromis niloticus</i>	Provision of <i>M. citrifolia</i> fruit flour through feed for 45 days.	The dose of 6 g/kg feed resulted in the highest resistance to <i>Streptococcus iniae</i> , which was indicated by an increase in total phagocytic activity by 56% (from 35% to 54.66%)	[39]
<i>Penaeus monodon</i>	Immersion in a solution of noni fruit flour for 15 minutes	Concentration of 60 grams/L of water was resistant to <i>Vibrio harveyi</i> bacteria attack with the highest survival rate, which was 93.3%	[8]

phagocytic activity by 56% (from 35% to 54.66%) [39]. Other studies have shown that noni fruit in the form of flour can increase the resistance of tiger shrimp to *Vibrio harveyi* bacterial infection. Previously, tiger prawns (*Penaeus monodon*) were treated by soaking in a solution of noni fruit flour for 15 minutes, then challenged (infected) with *Vibrio harveyi* bacteria at a density of  $10^7$  CFU/ml through immersion for 15 minutes. Flour concentration of 60 grams/L water is the best dose to increase the tiger shrimp's body resistance to these bacterial attacks, by producing a significantly higher survival ( $P < 0.05$ ) compared to the control, which is 93.3% [8].

In Table 2 it can be seen that *M. citrifolia* leaves and fruit can be used as immunostimulants that can increase the body's resistance of fish, with doses and preparations that are quite varied, namely in the form of flour and extracts. This shows that the bioactive compounds contained in the leaves and fruit, apart from being antibacterial, can also be used as an immunostimulant. As an immunostimulant, the bioactive ingredients contained in noni leaves and fruit are able to activate and improve the immune system by stimulating and improving immune system function [40]. Flavonoids are active polyphenolic compounds that can stimulate phagocytic cells and increase phagocytosis and leukocyte production [41,42]. Scopoletin is a phytonutrient scopoletin capable of increasing phagocytic activity and macrophage capacity of white blood cells [43]. Saponins can improve the immune system by

stimulating pancreatic cells to secrete more insulin [19]. *M. citrifolia* fruit extract is able to increase the physiological response of macrophages and the percentage of leukocyte cell count [43]. *M. citrifolia* fruit extract is able to activate and improve the immune system by stimulating and improving immune system function [40].

## 6. CONCLUSION

Several studies have shown that noni plays a role in overcoming diseases that infect cultured fish, both for treatment and prevention. The parts of *Morinda citrifolia* plant used are the leaves and fruit in various dosage forms, namely extract, flour and juice. The types of diseases that can be cured are bacterial diseases caused by *Aeromonas hydrophila* that infect *Leptobarbus hoevenii*, *Cyprinus carpio*, *Barbonymus gonionotus*, *Carassius auratus* and *Oreochromis niloticus* fish and parasitic diseases caused by *Argulus* sp., *Lernaea* sp. and *Trichodina* sp. Several types of fish, namely *Cyprinus carpio*, *Oreochromis niloticus* and *Penaeus monodon* increased body resistance after being treated with *M. citrifolia*, which was indicated by an increase in the number of leukocytes, an increase in total phagocytic activity and high survival after being challenged with pathogenic organisms.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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