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Potential of plants to treat argulosis disease in fresh water fish

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Abstract
Fresh water fish, such as carp (*Cyprinus carpio*), koi (*Cyprinus carpio*), koki (*Carassius auratus*) and comet (*Carassius auratus auratus*) have great opportunities for developing aquaculture in Indonesia. However, the presence of argulosis disease caused by ectoparasites *Argulus* sp. be one of the obstacles. This parasitic infestation can cause fish to experience a decrease in body weight, weakness, bleeding, secondary infection, decrease in sale value and even death. This condition economically will have an impact on decreasing the income of cultivators. The use of synthetic chemicals, including trichlorfon as an insecticide, has been used to control this ectoparasite. However, trichlorfon will have an impact on physiological changes, fish growth, and the balance of aquatic ecosystems, because it can leave residues that can enter into environmental components, the active ingredients are very difficult to decompose in nature and resistance can occur in target parasites so that the eggs can reappear when used. Insecticides not in accordance with the rules of use. In addition, it can cause residues in the body of the fish. Alternatives for controlling argulosis in fish farming can use medicinal ingredients derived from plants. Pharmacologically medicinal plants have therapeutic effects as antibacterial, antiparasitic and immunostimulant, apart from that they are safe for the environment and have minimal side effects for fish and humans who consume them. So the purpose of writing this article is to describe the potential of plants as medicinal plants to treat argulosis disease in cultivated freshwater fish. Based on the above studies, proves that several plant species, including *Morinda citrifolia, Carica papaya, Moringa oleifera, Syzygium aromaticum, Nicotiana tabacum, Allium sativum* and *Areca catechu*, have been able to control Argulosis disease caused by ectoparasites *Argulus* sp. which infects several types of cultivated fish including goldfish (*Cyprinus carpio*), koi (*Cyprinus carpio*), comets (*Carassius auratus auratus*), and koki (*Carassius auratus*). A treatment used by immersion. The dosage used varies depending on the preparation, the type of plant and the type and size of the fish**.**

Keywords: Medicinal plants, fish culture, control, argulosis

Introduction
Disease in fish farming is one of the factors that must be watched out for and is a major concern. Diseased fish can result in a decrease in the production of cultivated products, and can even cause fish death. Diseases in fish can be caused by infectious agents such as parasites, bacteria, and viruses [1]. *Argulus* sp. is a type of freshwater fish parasite, is a cause of argulosis in fish [2, 3]. This parasite belongs to the class Curtaceae, which is an ectoparasite known as fish lice. The size of this parasite is relatively large, 5 – 10 mm, often found attached to the fins, scales and around the head including the gills [4, 5]. This parasite is quite dangerous and threatens fish health, especially at the size of the fry, can cause high morbidity and mortality and economically causes losses for fish farmers [6]. Body parts of fish infected with parasites are characterized by red spots (inflammation) and swelling [4]. In controlling these parasites, fish farmers and entrepreneurs generally use various synthetic chemicals. Trichlorfon is one of the synthetic chemicals. at a dose of 0.25 ppm it can be used to control ectoparasites *Argulus* sp [5]. However, trichlorphone is an active ingredient in insecticides belonging to the organophosphate class, so its use can have an impact on physiological changes, fish growth, and the balance of aquatic ecosystems [7]. In addition, the use of insecticides can cause residues in fish [8]. The use of natural medicines derived from plants can be developed as an alternative for controlling parasitic diseases, especially argulosis. Medicinal plants are pharmacological has a therapeutic effect [9, 10].

Besides that, medicinal plants are safe for the environment and have minimal side effects for fish and humans who consume them [11, 12]. Various types of plants have been used as medicine by cultivators to treat various diseases that attack fish. The medicinal effect of plants, because they contain various secondary metabolites of flavonoids, saponins, tannins and others which have antibacterial activity [13]. Several types of plants that have been used as medicine include kipahit leaves, noni, betel nut, papaya, guava, and turmeric rhizome. *Tithonia diversifolia* leaves contain quassinoids which act as antibacterial, by oxidizing bacterial cell walls, *Morinda citrifolia* L. as an immunostimulant, *Piper betle* L. and *Curcuma longa* rhizomes are natural antibiotics used as antibiotics naturally, *Carica papaya* L. is often used as an antibacterial agent, *Psidium guajava* L. can be used as an antibacterial and anti-parasitic [14]. Based on the ability of plants as antibacterial, antiparasitic and immunostimulant, the purpose of writing this article is to describe the potential of medicinal plants as agents for treating argulosis in cultured freshwater fish.

2. Classification and morphology *Argulus* sp.

Argulus sp. includes ectoparasites in freshwater fish, a way of infecting fish by attaching themselves to the surface of the body and around the head, to the fins or gills. The disease caused by *Argulus* is called Argulosis [15]. This parasite consists of several species, while the classification of *Argulus* sp. is as follows:

Phylum: Arthropoda
Class: Crustacea
Subclass: Brachiura
Ordo: Argulidea
Family: Argulidae
Genus: *Argulus*
Species: *Argulus fiolaceus A. indicus, A. Japonicus, A. catastomi* [16]

Argulus sp. is quite large, ranging from 5 – 10 mm, divided into the cephalothorax and abdomen, the body shape is slightly oval dorsoventrally, the dorsal part is convex and the ventral part is slightly concave (Figure 2). The anterior part has two pairs of antennae, the first and second maxillae which function to attach themselves to the host, the suction device (proboscis) and the piercing device called the stylet is located in the preoral part. Has four pairs of legs which are located on the thorax function as swimming legs. It has a pair of large, short-stemmed faceted eyes. In female *Argulus* the thorax is a place to store eggs, while in male *Argulus* sp. the abdomen contains the testes (Figure 3) [17, 18, 19].

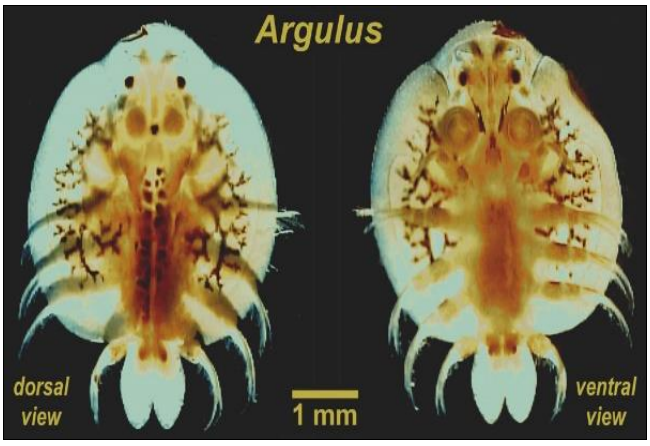

Fig 2: Dorsal and ventral body of *Argulus* sp.

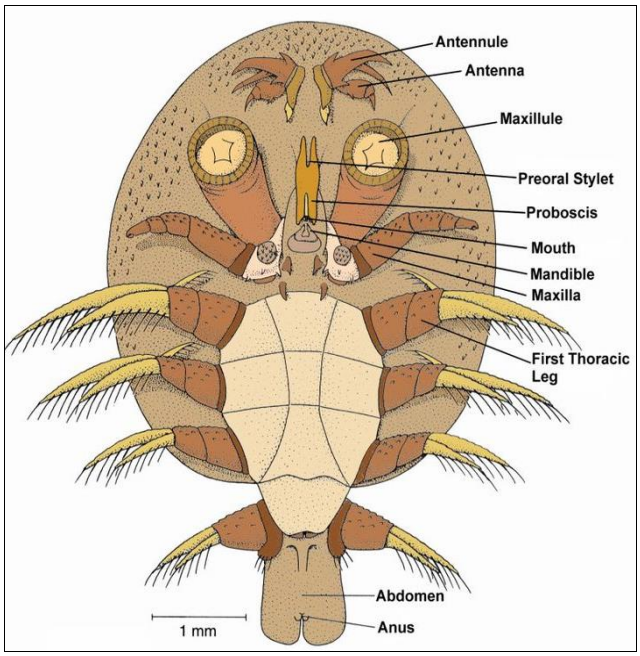

Fig 3: Morphology of *Argulus* sp.

3. Clinical symptoms and Patogenity of infestation *Argulus* sp.

Initial clinical symptoms of *Argulus* sp. Infected fish are characterized by increased mucus production, irregular swimming due to loss of balance, decreased appetite, irritation due to bites, hyperpigmentation in certain types of fish (tilapia) and rubbing against the body in an effort to relieve irritation or eliminate parasites. Further clinical symptoms are characterized by the presence of red spots on the surface of the fish's body, swelling around the gills and damage to the fins. Damage to the gills in large quantities, causes the fish to become weak and eventually die. Damage and red spots on the fish's body due to irritation, toxic effects in the form of anticoagulant enzymes released when the *Argulus* sp. is stung with an awl with a stylet. After piercing and injuring the fish's body, then the *Argulus* will suck the fish's body fluids with its proboscis. In addition, the presence of wounds due to attack by this parasite can lead to secondary infections by bacteria, viruses or fungi, this will worsen the condition of the fish. Therefore *Argulus* attacks are quite dangerous, because they can cause high morbidity and mortality in fish [20, 15, 21].

4. Phytochemical content of medicinal plants

The ability of plants as medicinal ingredients is related to chemical compounds, namely the secondary metabolite compounds they contain. The results of the phytochemical tests showed that almost all plants, in general, contain several secondary metabolite compounds, including flavonoids, saponins, tannins, terpenoids, phenols and steroids, which of course each type of plant has different levels/concentrations. These metabolite compounds have several pharmacological activities that are useful for human and animal health, namely as antibiotics, including as antiparasitic, antibacterial, antiviral, antifungal, antioxidant and immunostimulant which can trigger non-specific resistance of the body of fish [22, 23, 24]. Other active compounds contained in plants, including polypeptides, lectins, polyphenols, alkaloids, quinones, terpenoids, phenolics, have been shown to be very effective alternatives to antibiotics [25]. Several types of plants contain specific bioactive compounds that are not contained in other plant species, including *Paper betle* L., besides containing

flavonoids and tannins, it also contains specific compounds eugenol, chavibetol and hydroxychavicol and essential oils which act as antimicrobials and antioxidants [26]. Specific bioactive compounds contained in garlic are allicin and organosulfur compounds which function as antioxidants, anti-microbial and anti-carcinogenic [27]. Specific bioactive compounds contained in *Andrographis paniculate* Nees include lipopolysaccharide, Aflatoxin and nephroprotective [28]. *Curcuma longa* contains several bioactive compounds, including phenolics, terpenoids, diarylheptanoids, phenylpropenes, monoterpenes, sesquiterpenes, five diterpenes, triterpenoids, sterols, alkaloids [29], the bioactive compounds present in turmeric are curcumin, which is a phenolic compound, has antimicrobial and anti-inflammatory properties [30]. *Carica papaya* leaves contain phenols, tannins, flavonoids, saponins, alkaloids [31]. The active substance contained in the methanol extract of *C. papaya* leaves is effective as a natural antibiotic [32], so papaya seeds contain tannins, polyphenols, alkaloids, flavonoids, phenols and saponins [33], a specific compound found in papaya seeds is karpain, which is a pyroline alkaloid compound, which functions as a natural insecticide [34].

5. Application of plants for the management of Argulosis

Many applications of plants as alternative medicines for treating Argulosis in fish have been carried out. The ability of plants to control this disease is due to the presence of natural products in the form of chemical compounds in organic form, so they are safe to use, do not pose a risk that is harmful to fish, to humans who consume them or to the environment and do not cause resistance to parasites [24, 35]. Parts of plants that can be used as medicine include leaves, fruit, stems, roots, and rhizomes of various plants. Each type and part of the plant contains certain compounds that can be used as alternative drugs to replace inorganic chemical drugs. *Morinda citrifolia* fruit contains several compounds, including alkaloids, terpenoids, scopoletin and many nutrients that have many benefits, and the most active ingredients contained are alkaloids [36]. From the results of the study showed that the compounds contained in noni fruit produced through the extraction process with ethanol solvents were able to control the attack of *Argulus* sp. on the body of the *Carassius auratus*, marked by the release of the parasite from the fish's body after going through immersion in the extract solution. A dose of 2 drops/liter is able to release *Argulus* sp. from the fish's body [37]. The alkaloids contained in *M. citrifolia* fruit can paralyze the nervous system, while the sucker and proboscis as attachment and suction tools possessed by *Argulus* sp. to attach to the host are related to the nervous system, so that if the nervous system is paralyzed, the sucker and proboscis cannot attach to the host [38, 39]. Apart from being in the form of an extract, *M. citrifolia* fruit juice can treat *Carrasius auratus auratus* fish infected with *Argulus* sp. by immersion for 15 minutes. A concentration of 3.5% is a concentration that is quite effective and safe for fish [40]. Another study showed that *Carica papaya* seeds can prevent *Argulus* sp. infestation on *Carassius auratus* by immertion for 60 minutes. The optimum concentration of 50 ppt to prevent *Argulus* sp. infestation in *Carassius auratus* is 42% [39]. *Carica papaya* seeds contain a specific compound, namely karpain, which is a pyroline alkaloid compound, which functions as a natural insecticide [34]. As stated above, alkaloid compounds can paralyze the nervous system, which has an impact on inhibiting nerve impulses reaching the sucker/proboscis, so that *Argulus* sp. cannot attach to the host. Therefore *C. papaya* seeds are effective enough to prevent *Argulus* sp. attacks on fish. Research shows that the juice of *C. papaya* seeds at an optimal concentration of 80 ppt is reported to kill *Argulus* sp. [63]. Another type of plant that can control *Argulus* sp. infestation in fish is *Moringa oleifera*. The leaf part of this plant in the form of an extract with ethanol solvent can reduce *Argulus* sp. infestation on comet fish (*Carassius auratus auratus*) through a 12-hour immersion process. The ability of this plant to control *Argulus* sp. is due to its active compounds, namely anthraquinones and flavonoids which are anti-parasitic [43]. Apart from that, this plant also contains other active compounds as antiparasitics, namely saponins, alkaloids, carotenes and tannins [46]. Flavonoids can cause damage to cell membranes due to the protein denaturation process that occurs in cell membranes, resulting in inhibition of growth and resulting in death of the parasite [46]. Saponins can form complex compounds through hydrogen bonds in cell membranes which will damage the permeability of the parasite cell wall so that it can cause [47]. Tannins are spasmolytic in nature which can cause cell membranes to shrink and disrupt cell membrane permeability, so that cell activity will be disrupted, growth retardation can even experience death [47]. The process of damage to the parasite cell membrane is caused by protein denaturation and the dissolution of the fat contained in the cell membrane caused by the phenol component [49]. *Moringa oleifera* leaf extract can also be used to reduce *Argulus japonicus* infestation on goldfish (*C. auratus*). The optimal concentration of the 96% ethanol extract of *Moringa oleifera* leaves which can reduce infestation on goldfish for 69 hours is 700 ppm with an average percentage of reduction of 83.30% [50]. *M. oleifera* leaf extract has a high tannin content of 8.22%, while the alkaloid content is 0.42% and saponins are 1.75% [51]. Tannim is an antiparasitic compound, can bind to proteins so that it can interfere with the process of protein absorption, tannins can also shrink cell membranes thereby disrupting cell permeability [52]. *Syzygium aromaticum* oil at a concentration of 0.05 ml is able to treat carp (*Cyprinus carpio* L.) infected with the parasite *Argulus* sp. through the immersion process for 15 minutes [53]. This relates to the active substance contained in clove oil, namely eugenol which functions as an insecticide, fungicide, bactericide, as well as a nematicide [54]. In addition, cloves also contain flavonoids and tannins which function as antibacterial. *Nicotiana tabacum* leaves in the form of aqueous extract at a concentration of 9 ml/L can kill *Argulus* sp. which infects *Carassius auratus auratus* fish through immersion for 60 minutes. The mortality rate of *Argulus* sp. produced was 83.33% and the fish experienced healing. The healing process is characterized by shrinkage of the wound, response to feed, and normal swimming [55]. This shows that *N. tabacum* leaves can be used as an alternative material for controlling these ectoparasites in fish, this is related to the active compounds they contain, alkaloids, flavonoids, terpenoids and saponins [56]. Flavonoid and alkaloid compounds can increase the innate immunity of fish [57]. In addition, flavonoids are compounds that have anti-inflammatory abilities that can cover wounds in fish [52]. This is presumably due to the presence of flavonoids contained in *N. tabacum* leaf extract can also release *Argulus* sp. attached to the body of Koi fish (*Cyprinus carpio*) through immersion. A dose of 60% gives time to release the *Argulus* sp. sucker fastest (8 minutes 2 seconds) from the body of the fish, compared to doses of 20% (32 minutes 36 seconds) and 40%

(27 minutes 6 seconds) [58]. *Allium sativum* ability to overcome *Argulus* sp. attacks is due to the active compound it contains, namely allicin. These compounds are active substances that can kill bacteria and parasites and fungi [59]. Another opinion says that Allium sativum contains all derivatives as the most distinctive odour component, various disulfides work as antibiotics, nematicides, insecticides. *In vitro* allicin can also inhibit several enzymes [60]. Allycyn in high doses can be toxic to cells and cause a burning sensation in the skin or disturbances in the intestine [61]. Other plants that can overcome Argulosis attacks in fish are *Areca catechu* seed. Methanol extract of *Areca catechu* seed had a significant effect (P<0.05) on the mortality of ectoparasites *Argulus* sp. in goldfish by immersion for 60 minutes. The concentration of 40 ppm resulted in the mortality of *Argulus* sp. the highest, which is equal to 100% [62]. The ability of *A. catechu* as an antiparasitic is related to the active substances it contains, namely alkaloid compounds, including arecoline. These compounds are toxic, causing *Argulus* sp. become weak, move passively and end in death. This is because arecoline damages the nervous system, causing stiffness (paralysis) and decreased movement activity in organisms [63]. Symptoms of poisoning in *Argulus* sp. after being treated with A. catechu extract, it was indicated by the release of *Argulus* sp. from the body of the fish, hovering in the water with slow motion, finally at the bottom of the water and can only move the swimming legs. In the next stage, *Argulus* sp. will experience death which is marked by no movement at all. After *Argulus* sp. dead, the whole body changes colour from greenish to brownish yellow [62].

Table 1: Application of Plants Medicine for Argulosis

Plant	Preparation	Treatment	Dosage	Type of fish	Ref
Morinda citrifolia	fruit ethanol extract	Treatment via immersion 24 hours	2 tetes/L	*Carassius auratus*	37
Morinda citrifolia	fruit juice	Treatment via immersion 15 minutes	3,5%	*Carassius auratus*	40
Carica papaya	Seed juice	Preventive via immersion 60 minutes	50 ppt	*Carassius auratus auratus*	39
Carica papaya	Seed juice	Egg immersion 6 days.	80 ppt	*Argulus* egg	41
Moringa oleifera	Leaf ethanol extract	Immersion 12 Hours	25 ppm-62,5 ppm	*Carassius auratus auratus*	42
Moringa oleifera	Leaf ethanol extract ethanol 96%	Immersion 69 Hours	700 ppm	*Cyprinus carpio L*	48
Syzygium aromaticum	Oil	Immersion 15 Minutes	0,05 ppm	*Cyprinus carpio L*	51
Nicotiana tabacum	Leaf water Extract	Immersion 60 Minutes	9 ppm	*Carassius auratus auratus*	53
Allium sativum	Water extract	Immersion 8 Minutes 2 Seconds.	60%	*Cyprinus carpio*	56
Areca catechu	Seed methanol extract	Immersion 60 Minutes	40 ppm	*Carassius auratus.*	60

In the table above, it can be seen that several types of plants are able to control Argulosis disease which infects several types of freshwater fish, as well as *Argulus* eggs directly. However, the dosage used varies depending on the type and part of the plant, dosage form, type and size of fish. Each plant and part contains different active compounds, both in composition and concentration. In addition, each type of fish has a different response or tolerance to the drug substance given. This causes a variation in the dose in each treatment given.

Conclusion

Based on the above studies, proves that several plant species, including *Morinda citrifolia, Carica papaya, Moringa oleifera, Syzygium aromaticum, Nicotiana tabacum, Allium sativum* and *Areca catechu*, have been able to control Argulosis disease caused by ectoparasites *Argulus* sp. which infects several types of cultivated fish including carp (*Cyprinus carpio)*, koi fish (*Cyprinus carpio*), comet fish (*Carassius auratus auratus*), and goldfish (*Carassius auratus*). Treatment used by immersion. The dosage used varies depending on the preparation, the type of plant and the type and size of the fish**.**

Competing Interests

Author has declared that no competing interests exist.

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