Ectoparasite prevalence and intensity in *Glossogobius giuris* and phytochemical screening of *Anredera cordifolia*

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Abstract. Tank goby (*Glossogobius giuris*) from Lake Limboto is often infected with ectoparasites, which can harm the fish and make them difficult to raise. The objectives of this study were to identify the ectoparasites infecting *G. giuris* from Lake Limboto and to conduct a qualitative assessment of binahong (*Anredera cordifolia*) leaves for bioactive compounds with antiparasitic properties. A total of 100 fish were analyzed using wet-mount microscopy of mucus, gills, and caudal fins to assess prevalence, co-infection, and intensity. Standard qualitative tests were used to determine the phytochemical content of binahong leaves. Two types of ectoparasites were found: *Trichodina* sp. (97% of the time) and *Cichlidogyrus* sp. (65% of the time). 65% of the fish had both types of parasites at the same time. The mean intensity was highest for *Trichodina* sp. (81 parasites per infected fish; very heavy category), followed by *Cichlidogyrus* sp. (63) and co-infection (59). The phytochemical screening revealed the existence of significant classes, including flavonoids, alkaloids, saponins, tannins, and associated constituents. These results show that a locally important species hosts many ectoparasites and provide baseline parasitological measurements for Lake Limboto. They also support *A. cordifolia* as a potential plant for future in vivo efficacy trials.

Key Words: bioactive compounds, Binahong, aquaculture, Manggabai, parasite control.

Introduction. Tank goby (*Glossogobius giuris*), locally known as Manggabai fish, is a freshwater fish native to Lake Limboto that can be cultured (Suryandari & Krismono 2011). Intensive cultivation of freshwater fish is often at risk of disease emergence because, in intensive cultivation, fish are cultivated with high stocking densities and intensive feed use, causing a decrease in water quality, which will further trigger the onset of disease. Research on domesticating *G. giuris* for aquaculture has been successful. However, as a new aquaculture species, the tank goby (Manggabai) faces various constraints in fish farming (Koniyo & Juliana 2018). Various factors influence freshwater fish farming production, including disease, environmental quality, and seed and feed quality. Disease monitoring and prevention in fish farming are important, as they can inhibit growth and cause mortality in fish (Angreni et al 2018).

Disease outbreaks in freshwater fish farming can cause significant losses. Losses can occur in the form of sub-optimal growth of cultured commodities and increased fish mortality. The emergence of disease in fish results from interactions between three components in the aquatic ecosystem: weak hosts (fish), pathogenic organisms, and poor environmental quality. Diseases in fish are caused, among others, by parasites such in bacteria, fungi, and viruses (Juliana 2017). Both ectoparasites and endoparasites are problems in almost all freshwater fish farming activities. Countermeasures against parasites in freshwater fish farming have been carried out using antibiotics derived from chemicals, which can cause residues. The residues can decrease the quality of the media or cultivation environment, so this method is considered less effective (Juliana & Koniyo 2022).

In connection with these problems, safer solutions are required for parasite control in freshwater fish farming commodities. One alternative is to use active compounds derived from anti-parasitic, anti-fungal, anti-bacterial, and anti-viral plants. Active compounds derived from plants are relatively safe, easy to obtain, inexpensive, and do not leave harmful residues in the environment (Utami et al 2015).

One of the natural ingredients that has potential as an antibacterial material is binahong leaves (*Anredera cordifolia*). This plant can grow quickly, is easy to propagate, and does not need a large area for planting media in the yard. Binahong has round leaves, a creeping stem, and both a generative and a vegetative reproductive system (Pattipeiluhu et al 2023; Fitriyanti et al 2020). Binahong plants have soft, cylindrical stems twisted together, smooth surfaces, and red color. Binahong leaves are single, thin, limp leaflets, pointed tips, flat edges, notched bases, very short-stemmed, arranged alternately, light green, heart-shaped, 5-10 cm long, and 3-7 cm thick. Flowers are compound rhizomes, cluster-shaped, long-stemmed, appearing in the leaf axils; the cream-whitish crown of five strands is not attached, the crown strands are 0.5-1 cm long, and have a fragrant smell. Binahong roots are soft and rhizome shaped.

Binahong plants contain several chemical compounds, such as flavonoids, polyphenols, saponins, alkaloids, terpenoids, and essential oils, therefore they are efficacious in curing several diseases (in particular due to flavonoids, oleanolic acid, saponins, and ascorbic acid). Binahong plants have a higher concentration of saponin compounds than of other compounds, especially in tubers. Saponins include glycone compounds (sugars) and aglycone compounds, such as steroids and terpenoids. Binahong plants contain many bioactive compounds that function as antibacterial agents (Juliana et al 2020).

This study aimed to: (i) identify and quantify the ectoparasites infecting *G. giuris* from Lake Limboto using prevalence, co-infection, and intensity metrics; and (ii) conduct qualitative phytochemical screening of *A. cordifolia* leaves to document bioactive compound classes associated with antiparasitic potential. Application trials and growth, survival, or production endpoints were not evaluated.

Material and Method

Study area and fish sampling. *G. giuris* were collected from Lake Limboto (total n = 100, total length 8–10 cm). Fish were transported on ice-aerated containers to the Gorontalo Class I Fish Quarantine, Quality Control, and Fishery Product Safety Station Laboratory and examined within 24 h of capture. Wet-mount preparations of skin mucus, gills, and caudal fin were observed under light microscopy to (i) identify ectoparasites and (ii) estimate prevalence, co-infection, and mean intensity (number of parasites per infected fish) following standard parasitological procedures. No in vivo application trials (immersion or oral) were conducted in this study. Any reference to proposed treatment/maintenance protocols is retained only as future work and not part of the present dataset.

Identification of parasites in test of fish. Identification of the fish begins by measuring its length and initial weight and making initial observations of its morphological condition. The identification of parasites in *G. giuris* is carried out by collecting test animals and samples of body parts for examination. Sampling focuses on host organs generally attacked by parasites, namely the skin, tail, and gills. Observations of the host organs were made by preparing them for microscopy, which was carried out in stages during the acclimatization process. For each fish, wet-mount preparations of skin mucus, gills, and caudal fin were observed under a light microscope (×100–400). Ectoparasites were identified to genus using standard keys and references. The following metrics were estimated: prevalence (percentage of infected fish), co-infection (simultaneous infection by ≥2 taxa), and mean intensity (mean number of parasites per infected fish). Counts were recorded per host and summarized across the sample.

Preparation of bioactive compound extract. The procedure used for making binahong leaf extract was:

a. Binahong leaves used as extracts were collected fresh, not too old or too young. Old leaves tend to dry so that the chemical content needed is no longer there, while leaves that are too young still have low concentrations of phytochemicals.
b. The fresh, young leaves were washed thoroughly with clean water.
c. Before drying, the binahong leaves were cut into small pieces to facilitate the process. Drying was done indoors without exposure to sunlight.
d. After drying, the binahong leaves were weighed to determine their dry weight.
e. Dried binahong leaves were put into a glass and as much as 3 x 3000 mL of 96% ethanol were added and macerated for 24 hours.
f. The filtrate was separated using a rotary evaporator until no solvent dripped anymore.
g. The thick extract obtained was then used used only for qualitative phytochemical screening.

Qualitative tests detected major phytochemical classes (alkaloids, flavonoids, saponins, steroids/terpenoids, tannins), results were recorded as present/absent.

Parasitological metrics and data analysis. The observational variables and data gathering of this study were related to the indices calculated as in the formulae below, where the intensity was interpreted according to the criteria from Table 1 quantified ectoparasite infection in *G. giuris* using the following descriptive metrics:

Prevalence was analyzed to determine the percentage of *G. giuris* infested with parasites. The formula used is as follows (Kabata 1985; Koniyo et al 2020):

Prevalence (%) = ((Total fish infected with parasites)/(Total fish observed)) x 100

Intensity is analyzed to determine the level of parasite attack on *G. giuris*. The formula used is as follows (Kabata 1985; Koniyo et al 2020):

Intensity (individual/head) (%) = ((Total parasites infecting the fish)/(Parasite infected fish)) x 100

To determine the intensity of parasite attack on *G. giuris* the criteria presented in Table 1 was used.

Table 1

Criteria for the intensity of parasite attack on *Glossogobius giuris*

Attack intensity (Individual/head)	*Attack rate*
0.0–1.0	Healthy
>1–25	Light Weight
>25–50	Average
>50–75	Weight
>75	Very heavy

Results and Discussion. The initial stage of the research was to test the content of active compounds from *A. cordifolia* leaves that can function as antibacterials in freshwater fish infected with parasites. The content of active compounds in *A. cordifolia* leaves was determined through phytochemical tests. The next stage comprised qualitative phytochemical screening to document major bioactive classes. The results of the research on the content and response of active compounds of *A. cordifolia* leaves against ectoparasites are described in detail below:

Maceration of *A. cordifolia* tubers, leaves, and stems in distilled water, ethanol, and methanol revealed triterpenoid saponins, steroids, glycosides, and alkaloids (Astuti et al 2011). Extraction of the rhizome with petroleum ether, ethyl acetate, and 70%

ethanol yielded alkaloids, flavonoids, and saponins (Setiaji 2009). Selawa et al (2013) also studied extracting fresh and dried *A. cordifolia* leaves using ethanol solvent. Fresh *A. cordifolia* leaf samples and dried powder were extracted using ethanol.

Terpenoids are naturally occurring substances created by biosynthesis and are extensively dispersed in plants and animals. Isometric hydrocarbon molecules aid the body's chemical synthesis and cell recovery (Manoi 2009). Saponins are triterpene and sterol glycoside compounds found in higher plants. According to Robinson (1991), specific saponins exhibit antimicrobials. Specific saponins are essential because they can be produced from various plants with good results and are utilized as raw materials to manufacture steroid hormones in the health sector. Saponins can decrease cholesterol and have antioxidant, antiviral, and anticancer effects (Manoi 2009). The saponin test on *A. cordifolia* leaves was used to determine the presence of saponin compounds, which are known for their foaming properties, antimicrobial activity, and potential health benefits (Figure 1).

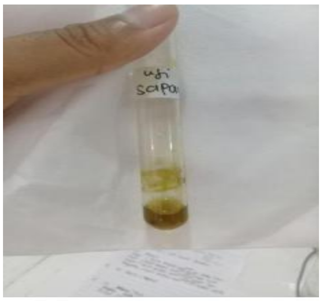

Figure 1. Saponin test on *Anredera cordifolia* leaves.

The flavonoid test on *A. cordifolia* leaves was also conducted as part of a research study (Figure 2). The test is used to detect flavonoid compounds in plant extracts. Flavonoids are essential phytochemicals known for their antioxidant, anti-inflammatory, and antimicrobial properties. The image shows multiple test tubes containing different reaction mixtures, each labeled with a different reagent. The color changes observed in some test tubes indicate a positive reaction to flavonoids (Figure 2). Typically, flavonoid tests involve reagents such as Shinoda Test (magnesium + hydrochloric acid) – which produces a red or orange color. Alkaline Reagent Test (NaOH or KOH) – produces a yellow solution, which turns colorless upon acidification. This test is crucial in phytochemical screening to confirm the presence of flavonoids in medicinal plants and evaluate their potential health benefits.

Figure 2. Flavonoid test on *Anredera cordifolia* leaves.

Flavonoids activity as antimicrobial agents that can accelerate wound healing is due to their ability to bind complex extracellular and soluble proteins and cell walls. Lipophilic flavonoids may damage microbial cell membranes. Alkaloids can be antibacterial. The suspected mechanism disrupts the components that make up the peptidoglycan in bacterial cells, affecting the integrity of the cell wall layer and causing cell death. The alkaloid test is used to detect alkaloid compounds in plant extracts (Figure 3). Alkaloids are nitrogen-containing organic compounds found in plants, known for their pharmacological activities, including antimicrobial, analgesic, and anti-inflammatory properties.

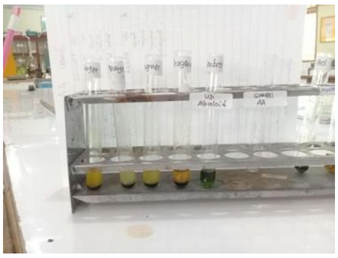

Figure 3. Alkaloid test on *Anredera cordifolia* leaves.

Based on pharmacological tests (Table 2), *A. cordifolia* leaves can act as antibacterial, antiobesity, antihyperglycemic, antimutagenic, antiviral, antiulcer, and anti-inflammatory. Further analysis of antimicrobial substances in *A. cordifolia* leaves contains saponins, alkaloids, polyphenols, terpenoids, essential oils, tannins, and flavonoids. Flavonoid and alkaloid content in *A. cordifolia* leaves can inhibit bacterial growth in fish. Based on the results of phytochemical tests conducted on *A. cordifolia* leaves, the following compounds were found:

Table 2

Phytochemical test results of *Anredera cordifolia* leaf

Sample test	*Parameter test*	*Analysis result*
Binahong leaf	Flavonoid	+ (Positive)
	Alkaloid	+ (Positive)
	Steroid	+ (Positive)
	Terpenoid	- (Negative)
	Saponin	+ (Positive)
	Tanin	+ (Positive)

***Identification of parasites in Manggabai fish*.** This study successfully identified two parasites infesting *G. giuris* collected from Lake Limboto, Gorontalo Regency (Table 3). The identification was conducted on a sample of 100 fish at the Gorontalo City Fish Quarantine Station Laboratory, focusing on ectoparasites found on the fish's mucus, gills, and tail fins. The results revealed the presence of *Trichodina* sp. and *Cichlidogyrus* sp., two ectoparasites known to affect freshwater fish.

Table 3

Types and prevalence of parasites in *Glossogobius giuris*

Parasite	*Infected fish*	*Total sample*	*Prevalence (%)*	*Notes*
Trichodina sp. (with/without *Cichlidogyrus* sp.)	97	100	97	Taxon-specific prevalence (non-exclusive)
Cichlidogyrus sp. (with/without Trichodina)	65	100	65	Taxon-specific prevalence (non-exclusive)
Co-infection (*Cichlidogyrus* sp. and *Trichodina* sp.)	65	100	65	Exclusive co-infection

Parasitological examination of 100 *G. giuris* from Lake Limboto identified two ectoparasite taxa: the ciliate *Trichodina* sp. and the monogenean *Cichlidogyrus* sp. Taxon-specific prevalence (non-exclusive, i.e., including co-infected fish) was 97% for *Trichodina* sp. and 65% for *Cichlidogyrus*; 65% of fish were co-infected by both taxa. Of the 100 fish, 32 carried *Trichodina* sp*.* only, 0 carried *Cichlidogyrus* sp. only, and 3 were uninfected, yielding an overall infection prevalence (any taxon) of 97%. Identifications were performed by light microscopy at the Gorontalo Class I Fish Quarantine, Quality Control, and Fishery Product Safety Station Laboratory (Figures 5–6).

The analysis showed a very high prevalence of *Trichodina* sp., at 97%, indicating that nearly all the sampled fish were infected. The high prevalence of *Trichodina* sp. aligns with previous findings that this protozoan is one of the most common ectoparasites found in freshwater environments, particularly affecting juvenile fish (Lom & Dyková 1992). *Trichodina* sp. is a ciliated protozoan ectoparasite that commonly colonizes the skin and gills of fish, particularly in their juvenile stages. This parasite can cause epithelial damage, irritation, and impaired respiratory function when it affects the gills. The high prevalence suggests that environmental conditions in Lake Limboto may be highly favorable for the growth and transmission of this parasite. Factors such as poor water quality, organic matter buildup, and fish stress are known to facilitate its proliferation. *Trichodina* sp*.* typically infest the skin and gills, causing epithelial damage, irritation, and impaired gill function (Buchmann & Bresciani 2006). Environments with poor water quality and high organic content often promote the proliferation of *Trichodina* sp*.* (Poynton et al 2004), which may explain its dominance in the samples collected from Limboto Lake.

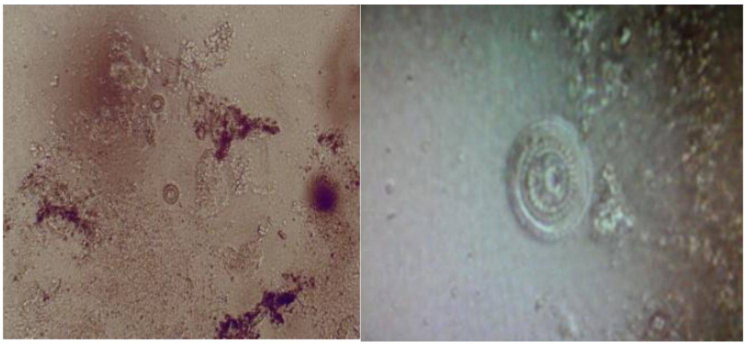

Figure 4. *Trichodina* sp*.*

In addition, *Cichlidogyrus* sp. was found in 65% of the fish, indicating a high prevalence. This genus of parasites belongs to the Monogenea class, typically infecting fish gills and causing tissue damage that leads to respiratory difficulties. Although less prevalent than *Trichodina* sp., the infection rate remains significant, indicating that *Cichlidogyrus* sp. poses a notable threat to fish health. Its presence in large numbers can result in decreased oxygen intake, increased stress, and a higher risk of secondary infections. This parasite belongs to the monogenean group and produces eggs that hatch into free-swimming larvae termed oncomiracidia. These larvae infect the host within a few hours and migrate to the target organ, maturing into an adult parasite.

Cichlidogyrus sp*.* is a monogenean discovered in the gills of manggabai fish from Lake Limboto, mainly found in fish gills, in unfavourable environmental circumstances, low water quality, and when fish are agitated (Figure 5). *Cichlidogyrus* sp. attaches to gill filaments and consumes epithelial cells, mucus, and blood in the gills. Young or debilitated mangabeys may die as a result of stress and severe infection. *Cichlidogyrus* sp. infecting manggabai fish were identified using a microscope, at the Fish Seed Centre.

Figure 5. *Cichlidogyrus* sp.

The findings of this study reveal a high prevalence of ectoparasites in *G. giuris* from Lake Limboto. *Trichodina* sp. was found in 97% of fish, Cichlidogyrus sp. in 65%, and 65% of fish were co-infected by both taxa. These data suggest significant parasitic pressure within the lake ecosystem, potentially linked to deteriorating environmental conditions.

Cichlidogyrus sp. is a monogenean parasite that primarily infects the gills, causing clinical signs such as gill pallor, epithelial hyperplasia, increased mucus production, and inflammation (Takashima & Hibiya 2009; Yuliartati 2011; Anshary 2008; Bawia 2014). The gills' anatomical exposure and high vascularization make them particularly vulnerable to environmental stress and parasitic invasion. In severe cases, infection can impair respiratory function, resulting in mortality (Pariselle & Euzet 2009; Febriawan 2021). Although less prevalent than *Trichodina* sp., *Cichlidogyrus* sp. infections pose serious health threats due to their potential to cause tissue damage and respiratory distress, especially under overcrowding or pollution (Koskivaara 1992). The co-occurrence of both parasites in a significant portion of the population suggests possible synergistic effects, where dual infections exacerbate tissue damage, suppress immune function, and increase susceptibility to opportunistic pathogens (Eiras et al 2010).

The elevated parasite load observed may reflect ecological imbalances in Lake Limboto. Poor water quality, organic waste accumulation, and eutrophication create favourable conditions for parasite proliferation and transmission (Marcogliese 2005). As such, these parasites may serve as effective bioindicators of aquatic ecosystem health. Effective management should include regular parasitological monitoring, water quality assessment, and environmental education for local stakeholders. Institutions like Fish Quarantine Station should strengthen disease surveillance and promote hygienic fish handling practices to mitigate further spread. Given the ecological and economic relevance of *G. giuris*, integrated strategies are essential to safeguard the health of wild fish populations and maintain ecosystem stability in Lake Limboto (Shinn et al 2015).

Intensity. The intensity of parasitic infections observed in *G. giuris* from Lake Limboto presents critical insights into the burden carried by individual hosts and the severity of infestation by each parasite species. Parasite intensity refers to the average number of parasites found per infected host, serving as a key epidemiological parameter for assessing parasite-host dynamics and potential pathological effects (Eiras et al 2010; Buchmann & Bresciani 2006; Sultana 2015). Results of the information on the prevalence of parasitic infections in manggabai fish in Gorontalo focus on three infection scenarios: *Trichodina* sp., *Cichlidogyrus* sp., and their combination (Table 4). The information supplied comprises the number of infected fish, the total number of samples collected, the intensity of infection (number of parasites per infected fish), and the infection criterion category based on the intensity level.

Table 4

Intensity of parasites in *Glossogobius giuris*

Parasite	*Number of infected fish*	*Total sample*	*Intensity*	*Criteria*
Trichodina sp.	97	100	81	Very heavy
Cichlidogyrus sp.	65	100	63	Average
Cichlidogyrus sp. & *Trichodina* sp.	65	100	63	Average

The findings revealed that *Trichodina* sp. was the most common parasite infecting manggabai fish in terms of the number of infected fish (97%) and the severity of infection (81). This "very heavy" category denotes that *Trichodina* sp. infection can seriously impact fish health. Infection is promoted by environmental factors, such as poor water quality, or a high density of fish population. Among the parasites identified, *Trichodina* sp. exhibited the highest intensity, with an average of 81 parasites per infected fish, classified as a "very heavy" infection. This high intensity suggests a substantial colonization of epithelial surfaces, particularly in mucosal regions such as the skin and gills, which are known to be preferred habitats for *Trichodina* sp., due to their ciliated morphology and attachment mechanisms (Lom & Dyková 1992). Such intense infestations are often associated with tissue irritation, excessive mucus production, and epithelial hyperplasia, which can compromise respiratory efficiency and the overall health of the host fish (Poynton et al 2004).

Cichlidogyrus sp*.* had a lower frequency (65%) with an infection intensity of 63. However, the combination of *Cichlidogyrus* sp. and *Trichodina* sp. infections had a prevalence of 73% with an infection intensity of 59. This combination of illnesses, while less severe, nevertheless poses a hazard to fish health since it can increase stress levels, resulting in a loss of fish resilience. Basyuni et al (2017) revealed that in vitro tests revealed that *A. cordifolia* leaf extract reduced the development of the bacteria *A. hydrophila*, with an inhibition zone surrounding the paper disc. The inhibitory growth of *A. hydrophila* increased as the extract concentration increased. Bacterial growth was inhibited in the diameter zone of *A. hydrophila* at different levels of extracts: 0 mm (0% negative control), 8.4 mm (0.2%), 9.4 mm (0.4%), 10.5 mm (0.6%), 11.9 mm (0.8%), and 27.5 mm (positive control). In contrast, *Cichlidogyrus* sp., a monogenean gill parasite, showed a moderate intensity of infection, at 63 parasites per infected fish. Although lower than the infection intensity of *Trichodina* sp., this still represents a significant parasitic burden. *Cichlidogyrus* sp. is known to cause structural damage to the gill lamellae, leading to compromised gas exchange and increased susceptibility to secondary infections (Pariselle & Euzet 2009). The "average" intensity category indicates the potential for chronic sub-lethal effects rather than acute mortality, consistent with previous studies on monogenean infections under moderate environmental stress (Koskivaara 1992).

This work may serve as a foundation for developing parasite control measures, such as utilizing *A. cordifolia* plants. Binahong contains active components, including flavonoids, saponins, and tannins, which possess antiparasitic and immunostimulant properties. The use of these plants is predicted to reduce the frequency and severity of illnesses while enhancing fish growth and survival. Compared to other work, this study may provide a foundation for developing parasite control measures, such as utilizing *A. cordifolia* plants. Binahong contains active components, including flavonoids, saponins, and tannins, which possess antiparasitic and immunostimulant properties. The usage of these plants is predicted to minimize the frequency and severity of illness while boosting fish growth and survival (Soliman et al 2013). Notably, co-infections with both *Trichodina* sp*.* and *Cichlidogyrus* sp. were found in 73% of the examined fish, with an intensity of 59 parasites per infected individual. While classified as "average," such dual infestations warrant serious concern due to the synergistic effects of multiple parasites targeting different anatomical systems. Co-infections exacerbate stress responses, impair immune function, and increase overall physiological burden, potentially leading to higher mortality rates and reduced population fitness (Marcogliese 2005; Shinn et al 2015).

From a management perspective, high-intensity infections, particularly those caused by *Trichodina* sp., may serve as bioindicators of environmental degradation (Sultana 2015). Monitoring intensity levels in wild fish populations can thus aid in the early detection of ecological imbalance and support conservation efforts to maintain aquatic biodiversity. Furthermore, the intensity profiles of different parasites can inform treatment protocols and fish health strategies in natural and aquaculture settings. Another study on the potential of epibiotic mixtures of Binahong and Temulawak leaf extracts in feed to overcome *A. hydrophila* infection in catfish (*Clarias gariepinus*) evaluated the effect of adding an epibiotic mixture of binahong and temulawak leaf extracts in feed on the blood profile and survival of catfish infected with *A. hydrophila* (Rochani et al 2021). Results showed that combining extracts increased fish survival to 90%, indicating their potential as a natural antimicrobial agent in fish farming.

A study examined the effect of soaking catfish in a combination of binahong leaf extract and garlic after infection with *A. hydrophila* (Kurniawan et al 2014). The results showed that soaking with the combination of extracts significantly increased fish survival and reduced clinical symptoms of illness, confirming its effectiveness as an alternative therapy in fish disease control. Binahong leaf extract increased the phagocytic activity of tilapia (*Oreochromis niloticus*) macrophages, lowering the incidence of parasite infections by 30% (Kaewda et al 2025). This shows that binahong can potentially treat parasite illnesses in manggabai fish. This study highlights the need for a holistic approach to maintaining manggabai fish health, particularly by including herbs like binahong in feed or water treatments. Furthermore, the findings of this study urge future investigation into the efficacy of binahong in dramatically lowering parasite infections, particularly severe infections caused by *Trichodina* sp.

Conclusions. *G. giuris* from Lake Limboto exhibited high ectoparasite burdens: *Trichodina* sp. showed 97% prevalence (mean intensity 81, very heavy), while *Cichlidogyrus* sp. occurred in 65% of fish (mean intensity 63), 65% were co-infected. Qualitative screening of *A. cordifolia* leaves revealed the presence of flavonoids, alkaloids, saponins, steroids, and tannins. These baseline data support parasitological surveillance and environmental management. No efficacy testing of binahong was performed; controlled in vivo trials are required.

Conflict of interest. The authors declare that there is no conflict of interest.

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