Fisheries Journal, 15 (6), 3349-3361 (2025)
http://doi.org/10.29303/jp.v15i6.2026

UTILIZATION OF HERBAL EXTRACTS AS ALTERNATIVE ANTIPARASITIC AGENTS IN CULTURED FISH: A REVIEW

Pemanfaatan Ekstrak Herbal Sebagai Alternatif Antiparasit pada Ikan Budidaya: Kajian Pustaka

Nurfitri Rahim*

Aquaculture Study Program, Muhammadiyah University of Education, Sorong

Kh. Ahmad Dahlan Street No. 01, Mariyat Pantai, Aimas, Sorong Regency, West Papua 98418

*Corresponding Author: nurfitri_rahim@unimudasorong.ac.id

(Received December 16th 2025; Accepted December 28th 2026)

ABSTRACT

Parasitic infections represent one of the major constraints in fish aquaculture, causing reduced growth performance, survival rates, and significant economic losses. Current parasite control strategies largely rely on synthetic chemicals, which may lead to residue accumulation, parasite resistance, and negative environmental impacts. Therefore, safer and more sustainable alternatives are urgently needed. This review aims to evaluate the potential of herbal extracts as alternative antiparasitic agents in fish culture based on available scientific evidence. A systematic descriptive literature review was conducted using databases including Google Scholar, ResearchGate, Scopus, and SINTA. A total of 13 publications that met the inclusion criteria were analyzed based on the type of herbal material, fish species tested, target parasites, application methods, effectiveness, and mechanisms of action. The results indicate that various herbal extracts exhibit high antiparasitic efficacy against a wide range of fish ectoparasites in both in vitro and in vivo studies. The antiparasitic activity is mainly associated with bioactive compounds such as terpenoids, flavonoids, alkaloids, phenolics, and essential oils, which act through membrane disruption, interference with the nervous system, and inhibition of parasite metabolism and attachment. Overall, this review concludes that herbal extracts have strong potential as environmentally friendly antiparasitic alternatives in aquaculture; however, their practical application requires further standardization of dosage, application methods, and field-scale validation to ensure efficacy and safety in commercial production systems.

Keywords: Aquaculture, Antiparasitic Agents, Fish Parasites, Herbal Extracts, Sustainable Disease Control

ABSTRAK

Infeksi parasit merupakan salah satu kendala utama dalam budidaya ikan karena menyebabkan penurunan pertumbuhan, kelangsungan hidup, serta kerugian ekonomi yang signifikan. Pengendalian parasit selama ini masih banyak bergantung pada bahan kimia sintetis yang berpotensi menimbulkan residu, resistensi parasit, dan dampak negatif terhadap lingkungan.

Oleh karena itu, diperlukan alternatif pengendalian yang lebih aman dan berkelanjutan. Kajian ini bertujuan untuk mengevaluasi potensi ekstrak herbal sebagai alternatif antiparasit pada ikan budidaya berdasarkan bukti ilmiah yang tersedia. Metode yang digunakan adalah kajian pustaka deskriptif sistematis dengan menelusuri literatur dari basis data Google Scholar, ResearchGate, Scopus, dan SINTA. Sebanyak 13 publikasi yang memenuhi kriteria inklusi dianalisis berdasarkan jenis bahan herbal, spesies ikan uji, target parasit, metode aplikasi, efektivitas, dan mekanisme kerja. Hasil kajian menunjukkan bahwa berbagai ekstrak herbal memiliki efektivitas tinggi terhadap beragam ektoparasit ikan, baik pada uji in vitro maupun in vivo. Aktivitas antiparasit tersebut terutama berkaitan dengan kandungan senyawa bioaktif seperti terpenoid, flavonoid, alkaloid, fenolik, dan minyak atsiri yang bekerja melalui perusakan membran sel, gangguan sistem saraf, serta hambatan terhadap metabolisme dan perlekatan parasit. Secara keseluruhan, kajian ini menyimpulkan bahwa ekstrak herbal berpotensi besar sebagai alternatif antiparasit yang ramah lingkungan dalam budidaya ikan, namun penerapannya masih memerlukan standardisasi dosis, metode aplikasi, serta uji lapangan untuk memastikan efektivitas dan keamanannya pada skala produksi.

Kata Kunci: Akuakultur, Antiparasit, Ekstrak herbal, Parasit ikan, Pengendalian penyakit berkelanjutan

INTRODUCTION

Aquaculture is one of the fastest-growing sectors in the fisheries industry and plays a crucial role in meeting the public's demand for animal protein. However, in practice, fish farming often faces significant challenges, one of which is parasitic infections. The increase of parasites in cultured fish leads to substantial economic losses due to reductions in both the quality and quantity of harvests, as well as decreased fish survival and growth rates (Buchmann, 2022).

To date, the management of parasitic infections in fish has largely relied on the use of synthetic chemicals and antiparasitic drugs such as formalin, malachite green, and various other chemical compounds. While these chemicals effectively control parasite infestations, they leave chemical residues on fish and in the environment, contribute to parasite resistance, and pose risks to human health and aquatic ecosystems (Joachim *et al.*, 2025). Therefore, in aquaculture health management, it is essential to seek alternatives that are safer, environmentally friendly, and sustainable.

One alternative that has gained considerable attention is the use of natural materials or herbal extracts as antiparasitic agents in fish farming. Herbal extracts are known to contain various bioactive compounds, including flavonoids, alkaloids, saponins, terpenoids, and essential oils, which exhibit antiparasitic, antibacterial, and antifungal activities (Al-Quraghuli & Ali, 2025; Rahim & Rossarie, 2023). Numerous studies have demonstrated the efficacy of herbal extracts, both in vitro and in vivo (Yilmaz & Yildiz, 2023), in suppressing the populations and activity of various parasite species affecting cultured fish. Furthermore, herbal extracts tend to be safer for the environment and do not leave harmful residues in fish products (Rahim *et al.*, 2020).

Nevertheless, the utilization of herbal extracts as antiparasitic alternatives in aquaculture still faces several challenges, including variability in effectiveness among plant species, determination of optimal dosages and application methods, and a limited understanding of the mechanisms of action of the bioactive compounds they contain. Therefore, a comprehensive literature review is necessary to summarize recent developments regarding the use of herbal extracts as antiparasitic agents in aquaculture, including the identification of potential plant species, target pathogens, mechanisms of action, as well as challenges and prospects for future development. This review is expected to provide valuable scientific information for researchers, fisheries practitioners, and policymakers in developing more effective, safe, and sustainable parasite control strategies within Indonesia's aquaculture sector.

RESEARCH METHODS

This study was conducted using a systematic descriptive approach. It encompassed various primary sources on the use of natural materials as antiparasitic agents in fish, including the processes of data collection, selection, and reorganization. Literature searches were carried out using multiple databases, such as Google Scholar, ResearchGate, Scopus, and SINTA. A total of thirteen publications meeting the inclusion criteria were analyzed, providing information on the level of efficacy, application techniques, and mechanisms of action of natural compounds against fish parasites. The analyzed variables included the types of plants used, fish species tested, target parasites, application procedures, utilization effectiveness, and levels of use. Subsequently, the data were analyzed descriptively by categorizing the research findings according to these variables. This process resulted in a structured mapping of the potential use of various natural materials as antiparasitic agents in fish.

RESULT

The review of various studies indicates that herbal extracts possess diverse potential as antiparasitic agents in cultured fish, as summarized in Table 1.

Table 1. Comparison of Natural Materials, Target Parasites, and Antiparasitic Effectiveness in Cultured Fish

No	Natural Material	Test Fish Species	Target Patogen	Target Pathogen	Application Method	Mechanism or Main Effect	References
1	Sage (*Salvia officinalis*)	Freshwater fish	*Ichthyophthirius multifiliis*	In vitro using 96-well microplate	100% efficacy against trophonts at various concentrations after 60 min exposure	Contains α-thujone (46.80%) with antihelminthic and selective neurotoxic activity, effectively immobilizing the parasite	Özil., (2023)
2.	Lavender (*Lavandula officinalis*)	Freshwater fish	*Ichthyophthirius multifiliis*	In vitro using 96-well microplate	100% efficacy against trophonts at various concentrations after 60 min exposure	Contains 1,8-cineole (32.65%), linalool (15%), and linalyl acetate (22.9%), which disrupt lipid membranes, inhibit protein and DNA synthesis, and interfere with trophont energy metabolism	Özil., (2023)
3	Oregano (*Origanum onites*)	Freshwater fish	*Ichthyophthirius multifiliis*	In vitro using 96-well microplate	100% efficacy against trophonts at various concentrations after 60 min exposure	Contains two phenolic terpenes with strong cytotoxic effects on microbial and protozoan cells	Özil., (2023)
4	Tea tree oil	Goldfish	*Dactylogirus* sp	In vivo and in vitro via immersion	Significant reduction in parasite intensity with 2 min immersion at 1 µl/ml	Main component terpinen-4-ol disrupts parasite cell membranes; lipophilic nature allows penetration through plasma membrane lipids	Yilmaz & Yildiz., (2023)

5	*Sargassum polycystum*	Grouper	Zeylanicobdella arugamensis	In vitro	100 mg/ml showed highest antiparasitic efficacy; mean total leech death 0.96 ± 0.44 min	Contains flavonoids (ephedrannin A and hinokiflavone), two organoarsenicals, four heterocyclic compounds, and two chlorophyll degradation products with antiparasitic properties	Haron *et al.,*, (2022)
6	Mentha × villosa	Nile tilapia	Monogenea	In vivo via immersion	Hydrolate concentration 20 ml/L showed 59.9% efficacy with greatest reductions in pathogen prevalence, mean abundance, and infection intensity	Main component carvone (±90%) with antiparasitic and insecticidal activity	Rafaela *et al.,*, (2021)
7	*Dioscorea collettii* var. Hypoglauca	Goldfish (*Carassius auratus*)	Gyrodactylus kobayashii	In vivo via immersion	Methanol extract most effective with EC50 4.17 mg/L; 100% efficacy at 10 mg/L	Contains dioscin which damages tegument structure, causing loss of microvilli, inhibiting parasite attachment and nutrient uptake, leading to rapid detachment and gradual death	Zhou *et al.,*, (2021)
8	Red ginger *Zingiber officinale* var. Rubrum	Goldfish (*Carassius auratus*)	Argulus japonicus	In vivo via immersion	Significantly reduced infestation ($p<0.05$); best treatment 350 ppm extract, 61.11% parasite release	Bioactive compounds (flavonoids, saponins, alkaloids, tannins, gingerol) disrupt parasite cell membranes via protein denaturation, causing cytoplasmic leakage and cell death	(Laurensia *et al.,*, 2023)

9	*Nephrolepis biserrata*	Marine cultured fish	Zeylanicobdella arugamensis	In vitro	Nephrolepis biserrata 2.50 mg/ml killed all leeches in 1.92 ± 0.59 min	Contains secondary metabolites including alkaloids, terpenoids, phenolics, and flavonoids with antiparasitic activity	Quadrupole *et al.*,, (2021)
10	Piper betle L	Nile tilapia	Tichodina sp.	In vivo via immersion	0.10 ppm reduced *Trichodina* intensity by 100%	Contains phenols and essential oils that disrupt cell membranes and denature proteins	Daya *et al.*,, 2018
12	*Curcuma longa*	Goldfish	Argulus spp	In vitro and in vivo	In vitro 200 ppm killed 100% *Argulus* spp. in 180 min; in vivo safe dose 12.5 ppm reduced infestation by 62.83% in 72 h	Contains sesquiterpenes (β-turmerone, α-turmerone, ar-turmerone) that disrupt parasite nervous system by inhibiting key enzymes such as acetylcholinesterase	Saengsitthisak *et al.*,, 2023
13	*Acanthus ilicifolius L*	Nile tilapia	Tichodina sp.	In vivo via immersion	Best treatment: 2 g/L immersion; prevalence 53.33%, intensity 1.34 (skin), 0.734 (gills); 100% seed survival	Contains flavonoids, saponins, tannins, and alkaloids; disrupts cell membranes, interferes with protein function, causing lysis and parasite death	Chandra *et al.*,, (2023)
14	*Rosmarinus officinalis*	Grouper	Zeylanicobdella sp	In vivo via immersion	Best concentration 15 ml/L, 60 min immersion reduced leech numbers by 44.85%	Active compounds (1,8-cineole, β-pinene, α-pinene, camphor) toxic to ectoparasites, disrupting nervous system and body surface	Zahra *et al.*,, (2023)

15	*Cassia alata L.*	Gourami	Argulus japonicus	In vivo via immersion	627 ppm most effective; infestation reduced to 35%	Contains alkaloids, flavonoids, saponins, tannins,terpenoids; disrupts membranes, nervous system, and attachment ability	Pradipta *et al.*,, (2023)
16	*Allium cepa*	Kurisi Fish	Sparicotyle chrysophrii	In vivo via feed	0.5 µg/ml showed effect; 5 µg/ml killed 90% larvae in 60 min	Contains thiosulfinate groups (reactive organosulfur) as main source of antiparasitic activity	Cabello-Gómez *et al.*,, (2022)
17	*Nephrolepis biserrata*	Grouper	Zeylanicobdella arugamensis	In vivo and In vitro	Strong dose-response effect; 100% leech mortality in all concentrations; in vitro death time decreased with increasing dose: 25 mg/ml in 25 min, 50 mg/ml in 12 min, 100 mg/ml in 5 min	Contains terpenoids, flavonoids, phenolics, and coumarins (e.g., chlorogenic acid, ivalin, isovelleral) with known antiparasitic activity	Shah *et al.*,, (2020)

DISCUSSION

Mechanisms of Herbal Materials as Antiparasitic Agents

Various herbal materials summarized in Table 1 demonstrate significant potential as antiparasitic agents in cultured fish. In general, the antiparasitic properties of herbal materials largely depend on the presence and concentration of bioactive compounds such as terpenoids, flavonoids, alkaloids, phenolics, and essential oils (Gajarmal *et al.,* 2025). These compounds directly affect the structure and function of parasite cells. Certain plant extracts, such as *Salvia officinalis*, *Lavandula officinalis*, and *Origanum onites*, were even able to completely eliminate *Ichthyophthirius multifiliis* in in vitro assays, indicating the strong potential of natural materials as alternatives for parasite control in aquaculture systems (Özil, 2023).

The primary mechanism of herbal antiparasitic action is the disruption of parasite cell membranes. Lipophilic compounds, such as terpinen-4-ol in tea tree oil, phenols and essential oils in *Piper betle*, and flavonoids and gingerol in red ginger, can penetrate the lipid layers of parasite plasma membranes (Mukherjee *et al.,* 2016). This process leads to protein denaturation, cytoplasmic leakage, and cellular dysfunction, ultimately resulting in parasite death, as observed in *Dactylogyrus* sp., *Trichodina* sp., and *Argulus japonicus* (Daya *et al.*, 2018; Laurensia *et al.*, 2023; Yilmaz & Yildiz, 2023). A similar mechanism has been reported for Acanthus ilicifolius, where flavonoids, saponins, and alkaloids contribute to parasite cell lysis and reduce infection intensity (Chandra *et al.,* 2023).

In addition to membrane disruption, several herbal compounds act by interfering with the nervous system of parasites. The α-thujone in Salvia officinalis has been reported to exert selective neurotoxic effects, immobilizing I. multifiliis trophonts (Özil, 2023). Extracts of Curcuma longa and Rosmarinus officinalis also exhibit neuroactive mechanisms. Sesquiterpenes such as turmerone, camphor, and 1,8-cineole inhibit acetylcholinesterase activity, resulting in reduced mobility, paralysis, and death in ectoparasites such as Argulus spp. and Zeylanicobdella sp. (Laurensia *et al.,* 2023; Zahra *et al.,* 2023).

For certain plant extracts, antiparasitic mechanisms involve disruption of specific structures and physiological functions of the parasite. The methanol extract of Dioscorea collettii var. hypoglauca, containing dioscin, was shown to damage the tegument structure of *Gyrodactylus kobayashii*, characterized by the loss of microvilli on the parasite surface. This damage hinders the parasite's ability to attach and absorb nutrients from the host, resulting in rapid detachment and gradual death (Zhou *et al.*, 2021). A similar physiological mechanism has been reported for the organosulfur thiosulfinate compounds from *Allium cepa*, which are highly reactive to parasite tissues (Cabello-Gómez *et al.*, 2022).

Combination extracts from *Sargassum polycystum* and *Nephrolepis biserrata* demonstrate more complex antiparasitic mechanisms, as they involve synergistic interactions of multiple secondary metabolites. Flavonoids, terpenoids, alkaloids, phenolics, organoarsenicals, and chlorophyll degradation products act together to accelerate the mortality of the marine leech *Zeylanicobdella arugamensis*. The high efficacy shown by these materials in both in vitro and in vivo assays demonstrates that herbal extracts possess multitarget mechanisms, making them promising candidates as environmentally friendly antiparasitic agents in fish aquaculture (Dawood *et al.,* 2021; Haron *et al.*, 2022).

Analysis of Herbal Material Effectiveness Based

Based on the data presented in the table, a general pattern emerges showing that almost all herbal materials exhibit high efficacy in inhibiting or killing fish ectoparasites. The primary trend observed is that lipophilic bioactive compounds, particularly terpenoids, phenolics, flavonoids, and alkaloids, tend to provide the strongest antiparasitic effects. Many herbal materials demonstrate very high efficacy (up to 100%) across different testing methods, both in vitro and in vivo, indicating that plant secondary metabolites have significant potential as natural antiparasitic agents. The effectiveness of most herbs also shows a dose-response pattern, where increasing concentration results in faster parasite mortality or higher parasite release rates (Haron *et al.*, 2022; Laurensia *et al.,* 2023; Özil, 2023; Saengsitthisak, 2023).

Comparisons among herbal materials indicate that plants with essential oil compositions rich in terpenoids, such as aromatic herbs, exhibit the highest levels of efficacy. These aromatic herbs act rapidly because terpenoids can penetrate parasite lipid membranes and disrupt internal structures. In contrast, herbs with a single dominant active component, such as hydrosols or simple extracts, tend to show moderate efficacy or require higher concentrations to achieve optimal results. Additionally, the application method affects efficacy; in vitro testing generally shows faster results compared to in vivo applications, which require dose adjustments to remain safe for the fish (Dawood *et al.,* 2021; Rafaela *et al.,* 2021; Yilmaz & Yildiz, 2023; Zahra *et al.,* 2023).

The relationship between bioactive compounds and efficacy demonstrates a consistent pattern. Terpenoids such as cineole, linalool, turmerone, and terpinen-4-ol generally act through cell membrane disruption and interference with the nervous system, resulting in parasite paralysis or death (Özil, 2023; Saengsitthisak, 2023). Phenolic compounds and flavonoids contribute to parasite membrane damage through protein denaturation and increased cell permeability, causing cytoplasmic leakage (Haron *et al.,* 2022; Pradipta *et al*, 2023). Meanwhile, alkaloids present in several herbs exhibit neurotoxic effects that impair the parasite's ability to attach to and survive on the host (Chandra *et al.,* 2023; Dawood *et al.,* 2021). In some marine plants, complex bioactive compounds such as organoarsenicals, coumarins, and sphingoids also display extremely rapid antiparasitic effects, sometimes within minutes, indicating that these unique chemical structures have strong potential for controlling ectoparasites (Dawood *et al.*, 2021; Laurensia *et al.*, 2023; Shah *et al.,* 2020). Overall, the efficacy of herbal materials is highly influenced by the type and combination of secondary metabolites, with lipophilic and selectively neurotoxic compounds being the primary determinants of successful inhibition and killing of parasites.

Advantages and Limitations of Using Herbal Plants in Fish Aquaculture

The use of herbal materials as antiparasitic agents in fish aquaculture demonstrates significant potential as an environmentally friendly alternative to synthetic chemicals. One of the main advantages is their eco-friendly nature, as the bioactive compounds in herbal plants are generally biodegradable and do not leave harmful chemical residues in aquatic environments. Several studies have shown that plant extracts such as *Sargassum polycystum* and *Nephrolepis biserrata* exhibit high antiparasitic efficacy against the marine leech *Zeylanicobdella arugamensis* without causing long-term chemical contamination. This is attributed to the presence of bioactive compounds such as flavonoids, terpenoids, phenolics, and coumarins, which act by disrupting parasite membrane structures and interfering with their nervous systems (Shah *et al.,* 2020).

In addition, herbal materials produce low residues and are safe for consumption, unlike synthetic chemicals that can leave hazardous residues in fish tissues. For instance, the use of turmeric oil (*Curcuma longa*) at a safe dose of 12.5 ppm can reduce *Argulus* spp. infestations by up to 62.83% without causing toxic effects on goldfish. Similarly, *Allium cepa* extract demonstrates high efficacy against *Sparicotyle chrysophrii* larvae, achieving up to 90% mortality at low doses, indicating high safety for both fish and end consumers (Cabello-Gómez *et al.,* 2022; Saengsitthisak, 2023).

Another advantage is that many herbal plants possess immunostimulatory activity, thus not only functioning as antiparasitic agents but also enhancing the fish immune system. Certain plants, such as *Cassia alata*, *Zingiber officinale* var. *rubrum*, and *Acanthus ilicifolius*, contain compounds like saponins, flavonoids, alkaloids, and tannins, which stimulate non-specific immune responses in fish, improve overall health, and increase resistance to secondary infections (Haron *et al.,* 2022; Pandunitaa *et al.*, 2023; Pradipta *et al.*, 2023).

However, the use of herbal materials also presents several limitations that must be considered. One major challenge is the variability in bioactive compound content, which can be influenced by environmental conditions, plant age, plant part used, and extraction methods. This results in inconsistent efficacy across studies. For example, the antiparasitic effectiveness of *Mentha villosa* and *Nephrolepis biserrata* varies depending on concentration and exposure time, leading to differences between in vitro and in vivo results (Shah *et al.,* 2020; Yilmaz & Yildiz, 2023).

Moreover, many herbal materials lack standardized dosing, so field applications often rely on empirical approaches or limited research results. For instance, *Rosmarinus officinalis* shows optimal efficacy at 15 mL/L, while *Cassia alata* requires 627 ppm to significantly reduce *Argulus japonicus* infestations. Such inconsistencies highlight the need for dosage standardization to ensure reliable and safe outcomes in aquaculture systems (Pradipta *et al.,* 2023; Zahra *et al.,* 2023).

Another limitation is the potential toxicity of active compounds in some plants. Compounds such as α-thujone in *Salvia officinalis* and terpinen-4-ol in tea tree oil are lipophilic and possess strong neurotoxic activity. While effective in immobilizing parasites such as *Ichthyophthirius multifiliis* and *Dactylogyrus* sp., improper dosing can endanger fish and non-target organisms in aquatic environments (Laurensia *et al.,* 2023; Özil, 2023; Yilmaz & Yildiz, 2023).

Based on findings from various studies, several research gaps remain regarding the use of herbal materials as antiparasitic agents in fish aquaculture. A major issue is the lack of standardized dosing. Each plant species exhibits a wide range of effective concentrations depending on fish species, target parasites, and application methods. For example, *Rosmarinus officinalis* is effective at 15 mL/L, *Cassia alata* requires 627 ppm for optimal results, and *Curcuma longa* is safe only up to 12.5 ppm (Pradipta *et al.*, 2023; Saengsitthisak, 2023; Zahra *et al.,* 2023). Without established standard dosages, field efficacy is difficult to guarantee and may pose toxicity risks if applied uncontrolled.

Furthermore, most research remains limited to laboratory tests (in vitro or in vivo), while field trials under actual aquaculture conditions are scarce. Consequently, data on long-term stability of efficacy, environmental interactions, and impacts on fish and ecosystems are still limited (Shah *et al.,* 2020). Additionally, developing stable and easily applicable formulations remains a significant challenge. Many herbal active compounds, such as flavonoids, terpenoids, and essential oils, are volatile or degrade under light and oxygen exposure, reducing their effectiveness during storage and application. For instance, α-thujone in *Salvia officinalis* and terpinen-4-ol in tea tree oil are lipophilic and unstable in open environments (Laurensia *et al.,* 2023; Özil, 2023).

CONCLUSION

This review confirms that herbal extracts possess strong scientific potential as safer and more sustainable alternative antiparasitic agents in aquaculture compared to synthetic chemicals. The bioactive compounds in these herbal materials act through multitarget mechanisms, including cell membrane disruption, nervous system interference, and inhibition of parasite metabolism and attachment. Conceptually, these mechanisms address the need for effective parasite control strategies without leaving harmful residues in fish, the environment, or for consumers.

ACKNOWLEDGMENT

On this occasion, the author expresses sincere gratitude to all parties who have provided assistance and support in the preparation and completion of this review article.

REFERENCES

Agustina, S. S. (2018). Uji Daya Antiparasit Konsentrasi Ekstrak Piper Betle L. Terhadap Parasit *Trichodina* sp. yang Menginfeksi Benih Ikan Nila (*Oreochromis niloticus*). *Seminar Nasional Kelautan XIII*, 91-16. Fakultas Teknik dan Ilmu Kelautan Universitas Hang Tuah.

Al-Quraghuli, A. Z. K., & Ali, J. M. (2025). Bioactive Compounds in Medicinal Plants As a Source of Anti-Parasitic. *Journal of Medical Genetics and Clinical Biology*, *2*(11), 499-510.

Buchmann, K. (2022). Control of Parasitic Diseases in Aquaculture. *Parasitology*, *149*(14), 1985-1997.

Cabello-Gómez, J. F., Aguinaga-Casañas, M. A., Falcón-Piñeiro, A., Elías González-Gragera, Raquel Márquez-Martín, M. del M. A., Bermúdez, L., Baños, A., Martínez-Bueno, & Manuel. (2022). Antibacterial and Antiparasitic Activity of Propyl-Propane- Thiosulfinate (PTS) and Propyl-Propane-Thiosulfonate (PTSO) from Allium Cepa Against Gilthead Sea Bream Pathogens in In Vitro and In Vivo Studies. *Molecules*, *27*, 1–15.

Chandra, A. B., & Aji, O. R. (2023). Pengaruh Ekstrak Daun Jeruju (*Acanthus ilicifolius* L.) dalam Menghambat *Trichodina* spp. pada Benih Ikan Nila (*Oreochromis niloticus* L.). *JRST (Jurnal Riset Sains dan Teknologi)*, *7*(2), 177-182. https://doi.org/10.30595/jrst.v7i2.16749

Gajarmal, A. A., Mane, S., Waghulkar, M., Lonare, M., Baheti, S., & Prasad, A. (2025). Ethno-Veterinary Medicinal Plants for the Effective Management of Parasitic Infestation in Livestock. *Toxicology International*, *32*(1), 181-205.

Haron, F. K., Shah, M. D., Yong, Y. S., Tan, J. K., Lal, M. T. M., & Venmathi Maran, B. A. (2022). Antiparasitic Potential of Methanol Extract of Brown Alga *Sargassum polycystum* (Phaeophyceae) and its LC-MS/MS Metabolite Profiling. *Diversity*, *14*(10), 796.

Joachim, A., Robertson, L. J., Ferroglio, E., Bäumer, W., & Leschnik, M. (2025). Antiparasitics Against Ectoparasites in Small Animals–Important Pharmaceutical Substances or Underestimated Environmental Hazards?. *Veterinary Parasitology*, 110557. https://doi.org/10.1016/j.vetpar.2025.110557

Laurensia, S., & Amin, M. (2023, December). The Effect of Red Ginger Extract (*Zingiber Officinale* Var. Rubrum) on Infestation of Argulus Japonicus in Goldfish (*Carassius auratus*). In *IOP Conference Series: Earth and Environmental Science*, *1273*(1) 012016. IOP Publishing.https://doi.org/10.1088/1755-1315/1273/1/012016

Mukherjee, N., Mukherjee, S., Saini, P., Roy, P., & P Sinha Babu, S. (2016). Phenolics and Terpenoids; The Promising New Search for Anthelmintics: A Critical Review. *Mini Reviews in Medicinal Chemistry*, *16*(17), 1415-1441. https://doi.org/10.2174/1389557516661511201210

Özil, Ö. (2023). Antiparasitic Activity of Medicinal Plants Against Protozoan Fish Parasite *Ichthyophthirius multifiliis*. *Israeli Journal of Aquaculture-Bamidgeh*, *75*(2), 1-9. https://doi.org/10.46989/001c.83257

Pandunitaa, R. A. R. C., Julyantoroa, P. G. S., & Putri, N. P. (2023). Pengaruh Pemberian Pakan Pelet dan *Artemia* sp. terhadap Kualitas Warna Ikan Badut (*Amphiprion ocellaris*). *Current Trends in Aquatic Science, VI* (*1)*, 23–26.

Pradipta, Y. A., & Wulansari, P. D. (2023). The Utilization of Ketepeng Cina (*Cassia alata* L.) Leaves Ethanol Extract As A Prevention of *Argulus japonicus* Infestation to Gourami Fish (*Osphronemus gouramy*). *Journal of Aquaculture and Fish Health*, *12*(1), 135-143.

Rahim, N., & Rossarie, D. (2023). Efektivitas Ekstrak *Ulva reticulata* pada Pakan dalam Mencegah Serangan Bakteri *Vibrio harveyi* pada Udang Windu (*Penaeus monodo*n). *Biolearning Journal*, *10*(2), 55-59.

Rahim, N., Wulan, S., & Zainuddin3, E. N. (2020). Potensi Ekstrak *Ulva reticulata* dalam Meningkatkan Aktivitas Lisozim dan Diferansiasi Hemosit pada Udang Windu (*Penaeus monodon)*. *Jurnal Aquafish Saintek*, *1*(13–29), 1–9.

Saengsitthisak, B., Chaisri, W., Mektrirat, R., Yano, T., & Pikulkaew, S. (2023). In Vitro and In Vivo Action of Turmeric Oil (*Curcuma longa* L.) Against *Argulus* spp. in Goldfish (*Carassius auratus*). *Open Veterinary Journal*, *13*(12), 1645. https://doi.org/10.5455/OVJ.2023.v13.i12.14

Shah, M. D., Alagar, B., Maran, V., Haron, F. K., Ransangan, J., Ching, F. F., Raehanah, S., PShaleh, M., & Shapawi, R. (2020). Antiparasitic potential of *Nephrolepis biserrata* Methanol Extract Against the Parasitic Leech *Zeylanicobdella arugamensis* (Hirudinea) and LC - QTOF Analysis. *Scientific Reports*, 1–10. https://doi.org/10.1038/s41598-020-79094-4

Shah, M. D., Tani, K., Yong, Y. S., Ching, F. F., Shaleh, S. R. M., Vairappan, C. S., & Venmathi Maran, B. A. (2021). Antiparasitic Potential of Chromatographic Fractions of *Nephrolepis biserrata* and Liquid Chromatography-Quadrupole Time-of-Flight-Mass Spectrometry Analysis. *Molecules*, *26*(2), 499.

Silva, L. R. D., Rodhermel, J. C. B., Andrade, J. I. A. D., Pereira, M. O., Chaaban, A., Bertoldi, F. C., & Jatobá, A. (2021). Antiparasitic Effect of Mentha× *Villosa hydrolate* Against Monogenean Parasites of The Nile tilapia. *Ciência Rural*, *51*(10), e20190980.

Yilmaz, B. H., & Yildiz, H. Y. (2023). Anthelmintic Effects of Peppermint (*Mentha piperita*), Lemon (*Citrus limon*), and Tea Tree (*Melaleuca alternifolia*) Essential Oils Against Monogenean Parasite (*Dactylogyrus* sp.) on Carp (*Cyprinus carpio*). *Helminthologia*, *60*(2), 125. https://doi.org/10.2478/helm-2023-0019

Zahra, A., Bakkara, O. R., Miranti, S., Irawan, H., Wulandari, R., Muzahar, M., & Yulianto, T. (2023). Application of Rosmery (*Rosmarinus officinalis*) Solution to Reduce Marine Leeches in "Cantang" Hybrid Grouper (*Epinephelus fuscoguttatus* x *Epinephelus lanceolatus*). In *BIO Web of Conferences* (Vol. 79, p. 13004). EDP Sciences.

Zhou, S., Dong, J., Liu, Y., Yang, Q., Xu, N., Yang, Y., & Ai, X. (2021). Antiparasitic Efficacy of Herbal Extracts and Active Compound Against *Gyrodactylus kobayashii* in *Carassius auratus. Frontiers in Veterinary Science*, *8*, 665072.https://doi.org/10.3389/fvets.2021.665072