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Biosecurity Implementation and Its Association with Disease Distribution in Koi Fish *Cyprinus carpio* Aquaculture in Jakarta, Indonesia

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Abstract

Biosecurity is a fundamental component in aquaculture systems for preventing pathogen introduction and controlling disease transmission. However, its effectiveness under field conditions remains insufficiently quantified. This study aimed to evaluate the implementation of biosecurity practices and analyze their relationship with disease distribution in koi fish *Cyprinus carpio* culture in Jakarta, Indonesia. The study was conducted at ten koi fish farms using field-based observations and laboratory analyses. Parasite examinations followed SNI 7303:2015, while bacterial identification referred to SNI 6332:2021. Biosecurity performance was assessed using a standardized scoring and grading system based on BKIPM criteria. The results demonstrated that biosecurity implementation ranged from "adequate" to "good," with scores between 57.05 and 87.39. All samples were negative for *Aeromonas salmonicida*, indicating the absence of detectable infections by this bacterial pathogen. In contrast, multiple ectoparasites were detected, including *Trichodina* sp., *Gyrodactylus* sp., *Dactylogyrus* sp., *Argulus* sp., *Chilodonella* sp., and *Ichthyophthirius multifiliis,* with parasite prevalence reaching 100% across all farms. Dactylogyrus sp. exhibited the highest dominance among other parasite species. The highest parasite intensity was recorded in Tambora (7 ind fish^{-1}). Importantly, correlation analysis revealed a very strong negative relationship (r = -0.98) between biosecurity score and parasite intensity. These findings highlight a critical gap between biosecurity implementation and its effectiveness against parasitic infections. Strengthening biosecurity protocols, particularly in environmental management and sanitation, is essential to enhance disease control and support the sustainability of koi aquaculture systems.
Keywords: aquaculture, biosecurity, ectoparasites, koi fish, prevalence

I. INTRODUCTION

Koi fish *Cyprinus carpio* is an economically important ornamental fish species that contributes significantly to the ornamental aquaculture industry at both global and national levels (Andrian *et al.*, 2024; Sari *et al.*, 2025). The increasing demand for koi fish has driven rapid expansion of aquaculture activities, particularly in urban areas such as Jakarta, where ornamental fish farming plays an important role in local economies. However, the intensification of aquaculture systems has also increased the risk of disease outbreaks, which remain a major constraint affecting productivity and sustainability (Haryanti *et al.*, 2023; Sari *et al.*, 2025).

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Disease occurrence in aquaculture results from complex interactions among host, pathogen, and environmental factors (Svobodova *et al.*, 2017; Singh *et al.*, 2022; Uma, 2025) . Poor water quality, high stocking densities, and inadequate management practices can increase fish susceptibility to pathogens, including bacteria and parasites. In densely populated farming areas such as Jakarta, the proximity of farms further enhances the risk of pathogen transmission, allowing diseases to spread rapidly across production units (Gundi *et al.*, 2025; Uma, 2025).

Among disease-causing agents, parasites represent one of the most persistent problems in freshwater aquaculture systems. Parasitic infections such as Dactylogyrus, Gyrodactylus, and *Ichthyophthirius multifiliis* are widely reported to cause physiological stress, reduced growth, and mortality in fish populations (Kumari *et al.*, 2024; Das *et al.*, 2025). The rapid life cycles and transmission capabilities of certain parasites make them difficult to control, especially under suboptimal environmental conditions (Hoai, 2020; Davidovich *et al.*, 2023).

Biosecurity has been recognized as a key strategy to prevent the introduction and spread of pathogens in aquaculture systems. It includes preventive measures such as quarantine procedures, sanitation, water quality management, and health monitoring. Effective biosecurity implementation is essential to minimize disease risks and maintain fish health, particularly in intensive aquaculture systems (Aly and Fathi, 2024; Othman *et al.*, 2024).

Despite its importance, the effectiveness of biosecurity practices in reducing disease occurrence under field conditions is still not fully quantified. Many studies emphasize the role of biosecurity in disease prevention, but quantitative evidence linking biosecurity performance to disease indicators such as parasite intensity remains limited, especially in ornamental fish culture systems (Aly and Fathi, 2024).

The ornamental fish aquaculture industry, particularly koi fish farming, is vulnerable due to frequent fish movement and potentially inadequate biosecurity practices. Parasitic infections, including those caused by Myxobolus koi, have been reported in koi populations, highlighting the importance of effective disease prevention and biosecurity measures (Saha and Bandyopadhyay, 2017; Yanuhar *et al.*, 2023). In addition, inadequate biosecurity practices in ornamental fish trade systems have been identified as important risk factors for pathogen transmission (Hood *et al.*, 2019). Therefore, strengthening biosecurity is not only essential for disease control but also for maintaining economic sustainability in aquaculture (Aly and Fathi, 2024; Chouhan *et al.*, 2026).

This study aimed to evaluate the implementation of biosecurity practices and analyze their relationship with disease distribution in koi fish culture in Jakarta, Indonesia. This study provides quantitative insights into the relationship between biosecurity performance and bacterial and parasitic infection indicators, contributing to the development of improved management strategies for sustainable aquaculture.

II. MATERIALS AND METHODS

2.1 Study Area and Duration

This study was conducted from February to March 2024 at several koi fish *Cyprinus carpio* farms located in Jakarta, Indonesia. Laboratory analyses were carried out at the Fish Health Laboratory of IPB University and the Fish Quarantine, Quality Control, and Safety of Fishery Products Agency (BKIPM), Jakarta.

2.2 Sampling Sites and Fish Collection

A total of ten koi fish farms were selected based on BKIPM records. The sampling sites represented different aquaculture areas in Jakarta. Three fish samples were randomly collected from each farm using lethal sampling method in accordance with standard fish.

2.3 Bacterial Identification

Bacterial identification focused on the detection of *Aeromonas salmonicida*. The examination was conducted using conventional microbiological methods following the Indonesian National Standard (SNI) 6332:2021. The procedures included bacterial isolation on Briliant Green Agar medium, purification on Trypic Soy Agar, and biochemical characterization.

2.4 Parasite Examination

Parasite identification was carried out following SNI 7303:2015. Fish samples were examined microscopically to identify ectoparasites present on the body surface, gills, and fins. Identification was based on the morphological characteristics of the observed parasites.

2.5 Biosecurity Assessment

Biosecurity practices were evaluated using a

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Table 1 Scoring dan grading criteria for biosecurity assessment.

Score interval	Grade
100-91	Very good
90-71	Good
70-51	Adequate
<50	Not feasible

scoring and grading system based on the BKIPM (2017) guidelines. The assessment covered several aspects, including infrastructure, personnel hygiene, fish handling, and environmental management. Each parameter was assessed according to four severity categories, ranging from minor, major, serious, to critical. The assessment results were then used to determine the biosecurity grade. The final score was calculated based on the severity categories using the following procedure:

a. Minor category: The number of minor lesions was multiplied by 5 to obtain value A and divided by the weighting factor of 1.

b. Major category: The number of major lesions was multiplied by 25 to obtain value B and divided by the weighting factor of 8.

c. Serious category: The number of serious lesions was multiplied by 70 to obtain value C and divided by the weighting factor of 11.

The final score was then calculated using the following equation: Final score = 100 − (A + B + C).

2.6 Data Analysis

Data were analyzed descriptively to evaluate biosecurity scores, parasite prevalence (%), parasite intensity (ind fish^{-1}), and parasite dominance (%). Pearson correlation analysis was performed using IBM SPSS Statistics version 22 to assess the strength and direction of the relationship between biosecurity scores and parasite intensity across sampling locations.

III. RESULT

3.1 Biosecurity Implementation

The results of the biosecurity assessment showed that biosecurity implementation in koi fish farms in Jakarta ranged from “adequate” to “good.” The biosecurity scores varied between 57.05 and 87.39. No farms were categorized as “not feasible.” Farms with higher scores demonstrated better implementation of biosecurity measures, including infrastructure, personnel hygiene, fish handling, and environmental management.

3.2 Bacterial Infection

Bacterial examination results indicated that all fish samples tested negative for *Aeromonas salmonicida*. No presence of this pathogenic bacteria was detected in any of the sampling locations based on the identification method following SNI 6332:2021.

3.3 Parasite Infection

Parasite examination revealed the presence of several ectoparasites in all sampling locations. The identified parasites included *Trichodina* sp., *Gyrodactylus* sp., *Dactylogyrus* sp., *Argulus* sp., *Chilodonella* sp., and *Ichthyophthirius multifiliis*. Parasite prevalence reached 100% across all sampling sites. The highest parasite intensity was recorded in Tambora, with a value of 7 ind fish^{-1}. Other locations showed varying levels of parasite intensity, indicating differences in parasite burden among farms. Among the identified parasites,

Table 2. Biosecurity scores, classification categories, and parasite intensity of koi fish (*Cyprinus carpio*) farms across different locations in Jakarta, Indonesia.

No	Location	Category of Findings				Score	Category	Intensity
		Minor	Major	Serious	Critical			
1	Kelapa Gading	1	1	2	-	79.16	Good	2.67
2	Cipayung	1	1	2	-	79.16	Good	3.33
3	Pulo Gadung	1	6	3	-	57.16	Adequate	6.67
4	Ciracas	1	4	4	-	57.16	Adequate	6.33
5	Jatinegara	1	1	2	-	79.16	Good	3.33
6	Kemayoran	1	4	2	-	69.78	Adequate	4.00
7	Pasar Minggu	1	5	3	-	60.29	Adequate	6.00
8	Tambora	1	4	4	-	57.05	Adequate	7.00
9	Kembangan	-	2	1	-	87.39	Good	1.67
10	Palmerah	1	6	2	-	63.53	Adequate	5.00

Table 3. Detection results of *Aeromonas salmonicida* in koi fish (*Cyprinus carpio*) based on bacteriological examination

No	Location	Result
1	Kelapa Gading	Negative
2	Cipayung	Negative
3	Pulo Gadung	Negative
4	Ciracas	Negative
5	Jatinegara	Negative
6	Kemayoran	Negative
7	Pasar Minggu	Negative
8	Tambora	Negative
9	Kembangan	Negative
10	Palmerah	Negative

Dactylogyrus sp. showed the highest dominance.

3.4 Pearson Correlation

The correlation analysis showed a strong negative relationship (r = -0.98) between biosecurity score and parasite intensity. This indicates that higher biosecurity scores were associated with lower parasite intensity in koi fish farms. The strong negative correlation suggests that better biosecurity implementation may be associated with reduced parasite burden in koi fish culture.

IV. DISCUSSION

Biosecurity practices in koi fish farms in Jakarta have been implemented at an "adequate" to "good" level, as reflected by biosecurity scores ranging from 57.05 to 87.39. This indicates that farmers had adopted basic biosecurity measures, including water management, sanitation, and fish handling. However,

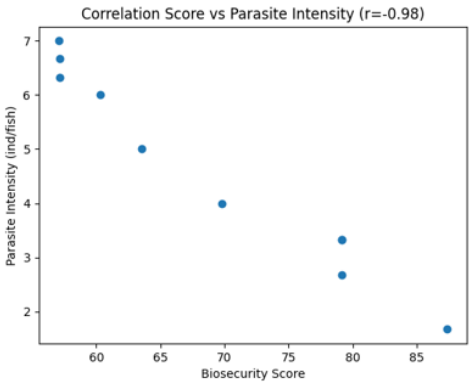


Figure 1. Strong negative correlation between biosecurity score and parasite intensity in cultured fish populations.

the presence of parasite infections across all sampling locations indicates that parasite occurrence persisted despite the implementation of these practices.

The high parasite prevalence (100%) observed in this study is consistent with field conditions reported in koi fish culture, where disease occurence is often associated with environmental factors and management practices (Yanuhar *et al.*, 2023; Silva *et al.*, 2021). Factors such as water quality fluctuations, stocking density, and proximity between farms in Jakarta may contribute to parasite transmission between culture units. Similar conditions have been reported to facilitate parasite transmission in aquaculture systems, particularly under suboptimal environmental management (Murray, 2013; Qadiri *et al.*, 2023).

The identification of several ectoparasites, including *Trichodina* sp., *Gyrodactylus* sp., *Dactylogyrus* sp., *Argulus* sp., *Chilodonella* sp., and *Ichthyophthirius multifiliis*, reflects the diversity of parasite infections observed in koi fish in this study. Among the identified parasites, *Dactylogyrus* sp. showed the highest dominance. This finding is consistent with previous observations that gill parasites are commonly encountered in freshwater aquaculture systems. These parasites can impair respiratory

Table 4. Detection results of parsites in koi fish (*Cyprinus carpio*) based on parasite examination.

Ectoparasite	Target Organ			Prevalence (%)	Intesity (ind fish^{-1})	Dominance (%)
	Gill	Mucus	Fin			
Tricodina	0	24	4	56,67	1,65	21,37
Gyrodactylus	24	0	2	40,00	2,17	19,85
Dactylogyrus	47	0	0	70,00	2,24	35,88
Argulus	0	20	2	36,67	2,00	16,79
Chilodonella	0	2	1	10,00	1,00	2,29
Ichtyopthirius	3	0	2	16,67	1,00	3,82

function, increase physiological stress, and negatively affect fish performance, potentially affecting production outcomes (Binning *et al.*, 2013; Kismiyati *et al.*, 2019; Yunikasari *et al.*, 2020; Afiyah *et al.*, 2023; Wulandari *et al.*, 2024).

In contrast, no *Aeromonas salmonicida* was detected in any of the examined samples, indicating that infection by this bacterial pathogen was not detected during the study period. This finding may indicate that bacterial infection by *A. salmonicida* was not a major health concern in the sampled farms during the study period. However, continued monitoring is necessary because the absence of detection in the sampled fish does not necessarily indicate the complete absence of the pathogen from the production system.

Importantly, correlation analysis revealed a very strong negative relationship (r = -0.98) between biosecurity score and parasite intensity. This finding indicates that farms with higher biosecurity scores tended to have lower parasite intensity. The observed relationship suggests that better biosecurity implementation may be associated with a lower parasite burden in koi fish culture. Similar findings have emphasized the importance of biosecurity in reducing disease risks in aquaculture systems (Aly and Fathi, 2024; Furlan *et al.*, 2025; Chouhan *et al.*, 2026).

This result supports the importance of biosecurity as part of disease prevention, particularly in intensive aquaculture systems. However, the present study provides additional quantitative information on the association between biosecurity performance and parasite intensity under field conditions, an area that remains relatively limited in ornamental fish research. Previous studies have also emphasized the importance of effective biosecurity implementation in reducing disease risks and maintaining fish health (Georges *et al.*, 2023; Chouhan *et al.*, 2026).

From a practical perspective, the results suggest that improvements in biosecurity implementation are still needed, particularly in aspects related to environmental management, sanitation, and routine health monitoring (Aly and Fathi, 2024; Carlino-Costa and Belo, 2025). Strengthening these components may help reduce parasite risks and improve the overall health status of cultured fish.

Overall, although biosecurity practices have been implemented by farmers, their potential contribution to disease prevention depends on the consistency and comprehensiveness of their application. Optimizing biosecurity strategies may therefore help minimize disease risks and support the sustainability of koi fish aquaculture in urban environments such as Jakarta.

V. CONCLUSION

This study demonstrates that biosecurity practices in koi (*Cyprinus carpio*) aquaculture systems in Jakarta were generally implemented at an “adequate” to “good” levels. Although no *Aeromonas salmonicida* was detected in the examined samples, ectoparasites were detected across all sampling farms, with a parasite prevalence of 100%, indicating that parasitic infections remain an important health concern in koi culture.

A key finding of this study is the very strong negative correlation (r = -0.98) between biosecurity scores and parasite intensity. This indicates that farms with higher biosecurity scores tended to have lower parasite intensity and provides quantitative evidence of an association between biosecurity implementation and parasite burden under field conditions.

Nevertheless, the persistence of high parasite prevalence suggests that that further improvements in biosecurity implementation are needed, particularly in environmental management, sanitation, and routine health monitoring. Consistent and comprehensive implementation of biosecurity measures may help reduce disease risks and support the sustainability of koi aquaculture in urban environments.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest, whether financial, personal, or otherwise, with any individuals or organizations related to the material discussed in this manuscript

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