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[Research Article]

THERMAL CHARACTERISTICS OF CEMENT AND SOIL PONDS AND THEIR IMPLICATIONS FOR WATER QUALITY AND THE SURVIVAL OF GOURAMI FISH

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ABSTRACT

This study aimed to examine the differences in water quality between concrete and earthen ponds and their effects on the survival rate of gourami fish. The experiment was conducted over 30 days using a total of 100 fish, with 50 fish reared in each pond type (4 × 6 m, 1 m depth). Observed parameters included temperature, pH, dissolved oxygen (DO), nitrate, and ammonia. Data were analyzed using SPSS through normality and homogeneity tests, Kruskal–Wallis, Mann–Whitney, and One-Way ANOVA, while the Aquaculture Water Quality Indices (AWQI) were calculated using MATLAB. The results showed that differences in thermal conductivity between concrete (1.7 W/mK) and soil (0.9 W/mK) led to higher and more fluctuating temperatures in concrete ponds. The temperature in concrete ponds was higher both in the morning (29.63°C) and afternoon (30.57°C) compared to earthen ponds (28.90°C and 29.90°C), with a daily increase of 0.94°C in concrete ponds and only 0.10°C in earthen ponds. The standard deviation also indicated greater fluctuations in concrete ponds (0.67–0.68) compared to earthen ponds (0.40). Although the AWQI values were higher in concrete ponds, the survival rate of gourami fish was greater in earthen ponds. These findings indicate that environmental stability plays a crucial role in the success of gourami aquaculture.

Keywords: AWQI, Water Quality, Gurami, Heat Transfer, Thermal Conductivity

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1. INTRODUCTION

Gourami (*Osphronemus goramy*) is one of Indonesia's leading freshwater aquaculture commodities with high economic value and continuously increasing market demand. This species is recognized for its distinctive flesh quality, high protein content, and relatively stable market price compared with other freshwater fish commodities. According to the Ministry of Marine Affairs and Fisheries, national gourami production has continued to increase in line with advances in aquaculture technology and the expansion of cultivation areas across various regions of Indonesia (Tambaunan, 2025).

However, the increase in production has not been accompanied by the availability of adequate information regarding [specify the particular aspect that constitutes the focus of the study, for example: the efficiency of locally sourced feed ingredients during the nursery phase, water quality management in small scale earthen ponds, or growth responses under optimal stocking densities in tropical environments]. Most existing studies remain general in scope and have not specifically examined [the variable or condition representing the identified research gap], despite its critical role in improving the productivity and sustainability of gourami aquaculture, particularly among small and medium scale fish farmers. Therefore, more focused studies are required to address this research gap.

One of the critical factors that is frequently overlooked is daily water temperature fluctuation. Substantial diurnal temperature variations, such as differences exceeding 5°C between daytime and nighttime, may induce physiological stress in gourami, resulting in reduced feed intake, metabolic disturbances, and ultimately decreased aquaculture productivity. The optimal water temperature for gourami growth ranges from 26 to 30°C, whereas the ideal water pH ranges from 6.5 to 8.0. Conditions outside these optimal ranges, particularly when accompanied by pronounced daily fluctuations, can reduce the specific growth rate (SGR) and increase mortality risk (Bayu, 2021).

Concrete ponds offer several advantages, including ease of maintenance, structural durability, and more effective control of pests and diseases. In contrast, earthen ponds provide a more natural environment through the presence of sediment layers that serve as habitats for decomposer microorganisms, while also requiring lower construction costs. The characteristics of pond bottom soil, particularly Red Yellow Podzolic (RYP) soil, include relatively acidic soil pH ranging from 4.9 to 5.7 and moderate to high organic matter content (Amrillah et al., 2024). Differences in the construction materials of these two pond types result in distinct physical and chemical properties that directly influence water quality parameters, including temperature, pH, dissolved oxygen (DO), nitrate, and ammonia.

Water temperature is one of the most fundamental water quality parameters because it regulates the rates of chemical and biochemical reactions within fish and the aquatic environment. Excessive diurnal temperature fluctuations may induce thermal stress in fish, reduce immune resistance, and increase susceptibility to diseases. In the context of different pond types, concrete has a higher thermal conductivity (approximately 1.7 W/mK) than soil (approximately 0.9 W/mK) (Amrillah et al., 2024).

The instability of pond water temperature represents one of the major challenges directly affecting fish growth and aquaculture productivity. Therefore, understanding the temperature dynamics of different pond types is essential for optimizing aquaculture management.

The differences in temperature characteristics between concrete and earthen ponds can be quantitatively explained through the physical mechanism of conductive heat transfer. The rate of heat transfer between the surrounding environment and the pond water follows Fourier's Law of Heat Conduction (Kolawole et al., 2015).

$$\frac{\boldsymbol{Q}}{\boldsymbol{t}} = \boldsymbol{k}.\boldsymbol{A}\ \frac{\Delta\boldsymbol{T}}{\boldsymbol{L}}$$

Where is the rate of heat transfer (W), is the thermal conductivity of the material (W/mK), and is the surface area of the pond wall or bottom (m^2). Equation (1) indicates that the rate of heat transfer is directly proportional to the thermal conductivity of the material. The higher the value of , the more efficiently the material conducts heat. Owing to its higher thermal conductivity, concrete walls transfer thermal energy from solar radiation to the pond water more efficiently during the daytime and, conversely, release heat more rapidly to the cooler surrounding environment at night. Consequently, concrete ponds experience greater diurnal temperature fluctuations. In contrast, soil, with its lower thermal conductivity, acts as a thermal insulator that slows the rate of heat transfer, resulting in more stable water temperatures in earthen ponds (Kolawole et al., 2015).

In addition to conduction, solar radiation serves as the primary energy source that not only heats pond water but also drives photosynthesis by phytoplankton. An increase in the photosynthetic rate produces oxygen and consumes CO_2, thereby shifting the carbonate equilibrium and increasing the water pH. Oxygen diffusion across the air–water and water–sediment interfaces also represents an important physical mechanism governing the distribution of dissolved oxygen (DO) within the pond. In earthen ponds, oxygen diffusion from the water column into organic matter-rich sediments results in a more pronounced reduction in DO compared with concrete ponds, which generally have only a thin sediment layer (Herlina, 2023). The interactions among solar radiation, water temperature, photosynthesis, dissolved oxygen, and pH form a complex and interdependent system.

Although numerous studies have investigated gourami aquaculture, research specifically comparing water quality between concrete and earthen ponds by integrating statistical analysis with the physical principles of heat transfer remains limited. Existing studies on water quality management in gourami hatcheries generally examine parameters such as pH and dissolved oxygen (DO) separately without relating them to the thermal properties of pond construction materials. Likewise, studies on gourami pond water quality monitoring have primarily focused on the development of sensor technologies and automated monitoring systems (Pitaloka et al., 2024). Integrating fisheries science with the principles of heat transfer physics could provide a more comprehensive understanding and establish a stronger scientific basis for technical decision-making in gourami aquaculture management.

A previous study conducted by Qorianas Tasya Sholihul Hadi (2023) on the suitability of water quality for common carp (*Cyprinus carpio*) aquaculture at Kludung Research Park serves as an important reference. The study employed the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) method and found that the water quality at the study site was classified as poor, primarily due to low water temperature and elevated ammonia concentrations. These findings underscore the importance of comprehensive water quality monitoring and management. According to the Indonesian National Standard (SNI) No. 8228 of 2015 concerning Good Fish Farming Practices (*Cara Budidaya Ikan yang Baik*, CBIB), freshwater aquaculture should comply with the water quality standards presented in Figure 1.

Wadah	Parameter kualitas air					Nomor SNI
	Suhu (^0C)	Kecerahan (cm)	pH	Oksigen terlarut (mg/l)	Amoniak (NH_3)	
Kolam air tenang :						
Nila	25-32	30-40	6,5-8,5	min.3	maks. 0,02	SNI 7550
Mas	25-30	25-60	6-8	min.4	maks.1	SNI 7875
Lele	25-30	25-50	6,5-8,5	min.4	maks. 0,01	SNI 01-6484.5
gurame	25-30	40-60	6,5-8,5	min.2	-	SNI 01-7241
patin :						
patin pasupati	27-31	30-40	6,5-8,5	min.3	maks.0,01	SNI 7551
patin siam	24-30	20-30	6-8,5	min.3	-	SNI 8001
papuyu	26-31	-	5-7	min.2	maks. 0,1	SNI 8002
udang galah	24-30	20-40	6,5-8,5	min.3	-	SNI 7999
Kolam air deras :						
Nila	22-32	-	6,5-7,5	-	-	SNI 8124
KJA :						
Nila	25-30	65-80	6,5-8,6	min.5	maks.0,02	SNI 01-6495.1
mas :						
mas strain majalaya	25-30	-	6,5-8,5	min.3	maks.0,02	SNI 8123
mas	25-30	65-80	6,5-8,6	min.5	maks.0,02	SNI 6494
Patin	27-32	> 30	6,5-8,5	min.3	maks. 0,01	SNI 7471.4

Figure 1. Water Quality Standards for Aquaculture (SNI 8228:2015).

Based on the aforementioned background, this study aimed to analyze the differences in water quality parameters, including temperature, pH, dissolved oxygen (DO), nitrate, and ammonia, between concrete and earthen ponds, as well as their effects on the survival rate of gourami (*Osphronemus goramy*). The measurement results were interpreted using the principles of heat transfer physics, including conduction, convection, and radiation. This approach was expected to explain the differences in the dynamics of water quality parameters between the two pond types and to provide a scientific understanding of the relationship between the thermal characteristics of ponds and the success of gourami aquaculture.

2. METHOD

This study was conducted over a period of 30 days in November at gourami (*Osphronemus goramy*) aquaculture ponds owned by local residents in Leuweung Sawo, Purwakarta District, Cilegon City, Banten Province, Indonesia. The study site was selected because it contained two pond types, namely a concrete pond and an earthen pond, both of which were maintained under relatively similar culture conditions and were easily accessible for routine water quality monitoring. Each pond measured 4 m in length, 3 m in width, and 1 m in water depth, resulting in a total water volume of 12 m^3 per pond. Each pond was stocked with 50 gourami fingerlings, with an average total length of 10–12 cm and an initial body weight of 25–30 g per fish.

The fish were fed a commercial pellet diet containing 28–30% crude protein. Feeding was carried out manually three times daily at 08:00, 12:00, and 16:00 (WIB), with a feeding rate equivalent to 3% of the total biomass per day. Water exchange was performed once a week by replacing 20% of the total pond volume (2.4 m^3) every Sunday at 09:00 (WIB). Water quality measurements were conducted both *in situ* at the study site and *ex situ* in the laboratory.

In situ measurements included water temperature and pH, which were recorded daily at 07:00, 12:00, and 17:00 (WIB) using a portable TDS meter and a portable pH meter. *Ex situ* analyses of dissolved oxygen (DO), nitrate, and ammonia were conducted every five days at 10:00 (WIB) at the Water Quality Laboratory (LABINDO) using a digital DO meter and a Hanna multiparameter photometer in accordance with standard analytical procedures.

The independent variable in this study was the pond type, consisting of concrete and earthen ponds. The dependent variables were the measured water quality parameters, including temperature, pH, dissolved oxygen (DO), nitrate, and ammonia. The controlled variables included the stocking density, with 50 fish maintained in each pond, and the pond dimensions, which measured approximately 4 × 6 m with a water depth of 1 m.

The collected data were analyzed statistically using the Independent Samples *t*-test to compare the mean values of water quality parameters (temperature, pH, dissolved oxygen, nitrate, and ammonia), as well as fish growth rate and survival rate, between the concrete and earthen ponds. All statistical analyses were performed at a 95% confidence level (α = 0.05) using SPSS version 26.0. The location of the study area is presented in Figure 2.

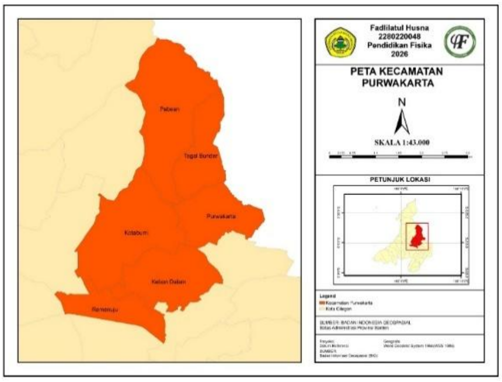

Figure 2. Location of the Field Study in Purwakarta District, Cilegon, Banten Province.

The study population consisted of gourami (*Osphronemus goramy*) with relatively uniform sizes, ranging from 10 to 20 cm in total length and 50 to 100 g in body weight per fish. All fish were healthy and free from visible physical deformities. A total of 50 fish were stocked in the concrete pond and 50 fish in the earthen pond, resulting in a total sample size of 100 fish.

Before the experiment commenced, both ponds were cleaned to remove excess debris and sediment, followed by initial water quality measurements to establish baseline data. Water quality parameters, including temperature and pH, were measured daily in the morning and afternoon, whereas dissolved oxygen (DO) was monitored periodically. Nitrate and ammonia concentrations were analyzed periodically in the laboratory. Throughout the study, the number of dead fish was recorded daily to determine the survival rate.

The fish survival rate was calculated using the Survival Rate (SR) formula, defined as the proportion of fish remaining alive at the end of the culture period relative to the initial number of fish stocked. The measured water quality data were subsequently compared with the water quality standards for gourami aquaculture established by the Indonesian National Standard (SNI) to evaluate the suitability of water conditions in the concrete and earthen ponds and their relationship with the survival rate of gourami (*Osphronemus goramy*).

3. RESULT AND DISCUSSION

This study evaluated water quality in two types of gourami (*Osphronemus goramy*) aquaculture ponds, namely concrete and earthen ponds, over a 30-day observation period. The analyzed parameters included water temperature, pH, dissolved oxygen (DO), nitrate, ammonia, and fish mortality. A total of 50 fish were stocked in each pond, with an average total length of 10–12 cm and an initial body weight of 25–30 g per fish.

During the study, four fish mortalities were recorded in the concrete pond, corresponding to a mortality rate of 8%. These mortalities occurred when the water temperature reached 33°C at 14:00 (WIB) on the 12th and 18th days of observation. In contrast, no mortality was observed in the earthen pond, although the maximum water temperature also reached 32.5°C. These findings indicate that the earthen pond possessed greater thermal buffering capacity, resulting in lower and slower diurnal temperature fluctuations than those observed in the concrete pond.

Regarding water pH, the concrete pond exhibited values ranging from 6.0 to 8.2, whereas the earthen pond maintained a narrower range of 6.4–7.8. Although a pH of 6.0 is below the optimal range for gourami growth (6.5–8.0), the fish survived without additional mortality directly attributable to low pH. This outcome may be explained by the physiological tolerance of gourami to pH values as low as 5.5, particularly when the decrease in pH occurs gradually (not exceeding 0.3 units per day) and is not accompanied by other environmental stressors, such as extreme temperatures or elevated ammonia concentrations. Nevertheless, at pH values below 6.5, fish exhibited reduced feed intake, and the specific growth rate (SGR) was observed to be lower than under optimal pH conditions.

Consequently, although gourami are able to survive under acidic conditions, such conditions adversely affect aquaculture productivity.

Table 1. Comparison of the Mean Water Quality Parameters with the Indonesian National Standard (SNI) Water Quality Criteria.

Parameter	SD (Concrete Pond)	SD (Earthen Pond)	Water Quality Standard (SNI)
Suhu	29,73 ± 0,89	29,23 ± 0,63	25-30
pH	7,47 ± 0,35	5,99 ± 0,42	6,5-8,5
DO (mg/L)	5,26 ± 0,68	4,62 ± 0,71	>4,0 mg/L
Nitrat (mg/L)	1,90 ± 0,55	2,68 ± 0,62	<10 mg/L
Ammonia (mg/L)	0,35 ± 0,12	0,81 ± 0,18	<0,5 mg/L

The results indicated that the concrete pond exhibited a higher mean water temperature than the earthen pond, ranging from 29.63 to 30.57°C, whereas the earthen pond ranged from 28.90 to 29.00°C. This difference is associated with the thermal properties of the pond materials, as concrete has a higher thermal conductivity than soil, thereby accelerating the absorption and transfer of heat into the water column. Furthermore, the pH and dissolved oxygen (DO) levels in the concrete pond were generally closer to the optimal range for freshwater aquaculture than those in the earthen pond, which tended to exhibit more acidic conditions due to the decomposition of organic matter within the sediment.

Table 2. Comparison of AWQI Values and Survival Rates between the Two Pond Types.

Pond Type	AWQI Value	Category	Survival Rate
Semen	65,8	Cukup	90,0%
Tanah	44,1	Buruk	96,7%

The integration of water quality parameters using the Aquaculture Water Quality Index (AWQI) yielded a score of 65.8 for the concrete pond, which was classified as "Fair" water quality, whereas the earthen pond obtained a score of 44.1, falling at the boundary between the "Poor" and "Fair" categories. Overall, these results indicate that the water quality of the concrete pond was relatively more favorable for supporting aquaculture conditions. Nevertheless, the survival rate of gourami (*Osphronemus goramy*) was slightly higher in the earthen pond (96.7%) than in the concrete pond (90.0%).

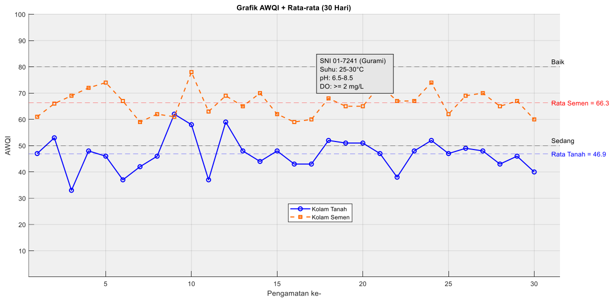

Figure 3. AWQI Calculation Results Generated Using MATLAB.

This finding indicates that the biological response of fish is not always directly proportional to the water quality index, as gourami (*Osphronemus goramy*) possess relatively high physiological tolerance to environmental conditions characterized by lower dissolved oxygen concentrations and more acidic pH levels.

The results revealed differences in the physical and chemical characteristics of the water between the concrete and earthen ponds used for gourami (*Osphronemus goramy*) aquaculture. Descriptive analysis showed that the concrete pond exhibited higher water temperatures and greater diurnal temperature fluctuations than the earthen pond. The standard deviation of water temperature was also higher in the concrete pond, indicating more pronounced thermal variability. In contrast, the earthen pond maintained a more stable temperature pattern throughout the observation period.

The differences in the temperature characteristics between the two pond types can be explained by the mechanism of heat transfer through the pond construction materials. From a physics perspective, heat transfer through the pond walls follows Fourier's law of heat conduction.

$$\frac{Q}{t} = k\,A\,\frac{\Delta T}{L}$$

Where is the rate of heat transfer (*heat flux*), is the thermal conductivity of the material, is the surface area, is the temperature difference between the two sides of the material, and is the material thickness (Incropera et al., 2011). The thermal conductivity of a material determines its ability to transfer thermal energy from the surrounding environment to the pond water system.

Concrete exhibits a relatively high thermal conductivity (approximately 1.0–1.7 W/mK), whereas soil generally has a lower thermal conductivity (<1.0 W/mK), depending on its texture and moisture content (Kolawole et al., 2015). This difference enables the walls of concrete ponds to transfer thermal energy from solar radiation into the pond water more efficiently. Consequently, concrete ponds experience a more rapid increase in water temperature during the daytime and a relatively faster decrease in temperature at night. In contrast, soil functions as a relatively effective thermal insulator, thereby reducing the rate of heat transfer between the surrounding environment and the pond water. As a result, earthen ponds exhibit smaller diurnal temperature fluctuations and greater thermal stability.

In addition to heat conduction through the pond walls, heat distribution within the water column is also governed by the process of natural convection. As solar radiation heats the surface layer of the water, the warmer water, having a lower density, rises, while the cooler and denser water sinks. This process generates convective currents that promote a more uniform distribution of temperature throughout the water column (Turner, 1973). In concrete ponds, the more intensive heating produces a greater temperature gradient, resulting in stronger convective circulation. These convective currents not only influence heat distribution but also facilitate the mixing of dissolved gases within the water.

The convective dynamics also affect the distribution of dissolved oxygen (DO). Oxygen enters aquatic systems primarily through atmospheric diffusion and the photosynthetic activity of autotrophic organisms. When convection is more active, oxygen entering from the water surface can be distributed more uniformly throughout the water column (Boyd, 2015). This mechanism explains why the DO concentration in the concrete pond was descriptively slightly higher than that in the earthen pond, even though higher water temperatures are theoretically associated with lower oxygen solubility.

Solar radiation also influences the chemical dynamics of aquatic systems by stimulating phytoplankton photosynthesis. Higher solar radiation intensity enhances oxygen production while reducing the concentration of dissolved carbon dioxide (CO_2). The reduction in dissolved CO_2 shifts the carbonate equilibrium, leading to a decrease in hydrogen ion (H^+) concentration and, consequently, an increase in water pH (Wetzel, 2001). This mechanism is consistent with the findings of the present study, in which the mean pH of the concrete pond was approximately 7.47, whereas that of the earthen pond was approximately 5.99.

The difference in dissolved oxygen (DO) concentrations between the two pond systems can also be explained by the interaction between oxygen diffusion and oxygen consumption by pond sediments. In earthen ponds, sediments rich in organic matter increase the oxygen demand required for microbial decomposition, commonly referred to as sediment oxygen demand (Boyd & Tucker, 1998). As a result, a considerable portion of the oxygen entering the water is consumed by microbial respiration within the sediment. In contrast, concrete ponds have relatively hard bottoms with minimal sediment accumulation, resulting in lower sediment oxygen demand.

From a physicochemical perspective, ammonia dynamics in aquatic systems are governed by the equilibrium between unionized ammonia (NH_3) and ionized ammonium (NH_4^+):

$$\boldsymbol{NH_3 + H^+ \rightleftharpoons NH_4^+}$$

The proportion of unionized ammonia (NH_3) increases under conditions of higher pH and temperature, whereas at lower pH values, ammonia predominantly exists in the form of ammonium (NH_4^+), which is relatively less toxic to aquatic organisms (Emerson et al., 1975). In the present study, the concrete pond exhibited slightly higher pH and temperature, which theoretically increased the proportion of unionized ammonia (NH_3). In contrast, the lower pH of the earthen pond favored the predominance of ammonium (NH_4^+), resulting in a more stable and less toxic chemical environment.

The implications of these physical and chemical processes were reflected in the biological responses of gourami (*Osphronemus goramy*). Although the Aquaculture Water Quality Index (AWQI) indicated a higher score for the concrete pond, the survival rate of gourami was slightly higher in the earthen pond. These findings suggest that greater thermal stability and the lower potential toxicity of ammonia may provide a more favorable environment for gourami culture than conditions characterized by larger temperature fluctuations.

The water quality dynamics observed in both pond systems resulted from complex interactions among multiple physical and chemical processes, including heat conduction through pond materials, convection within the water column, solar radiation, oxygen diffusion, and chemical equilibrium in the aquatic environment. This applied physics approach provides a more comprehensive understanding of the relationships among pond material properties, energy dynamics, and the biological responses of cultured organisms.

4. CONCLUSION

This study demonstrated that the water quality of the concrete pond was generally superior to that of the earthen pond based on the measured physicochemical parameters. The concrete pond exhibited a mean pH of 7.47, which falls within the optimal range for gourami (*Osphronemus goramy*) aquaculture (6.55–8.5), and a mean dissolved oxygen (DO) concentration of 5.26 mg/L, which was higher than that of the earthen pond (4.62 mg/L). The Aquaculture Water Quality Index (AWQI) also revealed a distinct difference between the two pond types, with the concrete pond achieving a score of 65.8 (Fair category), whereas the earthen pond obtained a score of 44.1 (Poor category). These findings indicate that, from an integrated water quality perspective, the concrete pond provided more suitable conditions for aquaculture.

Nevertheless, the study yielded an interesting finding in that the survival rate of gourami was higher in the earthen pond (96.7%) than in the concrete pond (90.0%). This phenomenon can be explained by the lower thermal conductivity of soil, which promotes greater thermal stability and consequently reduces thermal stress on the fish. Furthermore, the lower pH observed in the earthen pond favored the predominance of ammonium (NH_4^+), which is relatively less toxic than unionized ammonia (NH_3). Therefore, although the overall water quality index of the earthen pond was lower, its greater thermal stability may provide a more favorable environment for the survival and adaptation of gourami.

This study demonstrates that differences in pond construction materials influence heat transfer mechanisms, water quality dynamics, and the biological responses of fish. Concrete ponds tend to provide more favorable chemical water quality, whereas earthen ponds offer greater thermal stability. Therefore, effective gourami (*Osphronemus goramy*) aquaculture management should consider not only conventional water quality parameters but also the physical dynamics of the aquatic environment.

This study has several limitations. First, the investigation was conducted using only two pond types, namely concrete and earthen ponds. Second, the assessed water quality parameters were limited to temperature, pH, dissolved oxygen (DO), nitrate, and ammonia. Third, the study focused exclusively on gourami (*Osphronemus goramy*), limiting the generalizability of the findings to other cultured fish species. Furthermore, statistical analyses were performed using IBM SPSS to evaluate the statistical significance of the measured variables, while MATLAB was employed to calculate the Aquaculture Water Quality Index (AWQI). Finally, weather conditions and other external environmental factors were not specifically controlled or analyzed, which may have influenced the observed variations in water quality and fish performance.

5. REFERENCES

Adolph, R. (2016). Infestasi *Argulus* pada ikan mas (*Cyprinus carpio*, L.) di dasar kolam tanah dan beton, Kecamatan Muntilan dan Mungkid, Kabupaten Magelang. *Jurnal Akuakultur Sungai dan Danau*, 6(2), 1–23.

Annria, A. F., & Rahmaningsih, S. (2018). Kajian teknis faktor abiotik pada embung bekas galian tanah liat PT. Semen Indonesia Tbk. untuk pemanfaatan budidaya ikan dengan teknologi KJA [Technical study of abiotic factors in clay embankment used at PT. Semen Indonesia Tbk for utilization of fish farming with KJA technology]. *Jurnal Ilmiah Perikanan dan Kelautan*, 10(2), 95–105. https://doi.org/10.20473/jipk.v10i2.9825

Bangkit, I., Suryadi, B., Putra Kelana, P., & Subhan, U. (2022). Studi kesesuaian kualitas air untuk budidaya ikan mas (*Cyprinus carpio*) strain Majalaya guna mendukung program Kampung Lauk di Kabupaten Bandung [Study of water quality suitability for goldfish (*Cyprinus carpio*) Majalaya strain cultivation to support Lauk Village program in Bandung Regency]. *Aurelia Journal*, 4(1), 71–78.

Bayu, B. (2021). *Penelitian konduktivitas termal terhadap tanah sebagai bahan konstruksi* [Skripsi/Tesis tidak diterbitkan]. Universitas Tridinanti.

Emmanuelkolawole, A., & Olawale Ahmed, O. (2015). *Study of interrelationship among water quality parameters in earthen pond and concrete tank* [Preprint]. PeerJ Preprints. http://dx.doi.org/10.7287/peerj.preprints.845v1

George, A., Albert, G., James, N., & Marine, K. (2018). Effect of pond type on physicochemical parameters, phytoplankton diversity and primary production in Kisii, Kenya. *International Journal of Fisheries and Aquatic Studies*, 6(6), 125–130.

Herlina, H., Burhanuddin, B., Malik, A., Murni, M., & Saleh, S. (2023). Pengaruh oksigen terlarut terhadap laju mineralisasi amonia pada pemeliharaan udang vaname (*Litopenaeus vannamei*) [Effect of dissolved oxygen on the rate of mineralization of ammonia in Pacific white shrimp culture]. *Jurnal Ruaya*, 11(1), 80–85.

Jefri, M., Haris, A., & Burhanudin. (2016). Kelayakan parameter fisika kualitas air untuk usaha budidaya ikan bandeng dengan sistem Keramba Jaring Tancap (KJT) pada lahan bekas galian batu bara. *Jurnal Ilmu Perikanan Tropis*, 22(1), 15–23.

Meilano, I., Abidin, H. Z., & Natawidjaya, D. H. (2009). Using 1-Hz GPS data to measure deformation caused by the Bengkulu earthquake. Dalam *Proceeding of International Symposium on Earthquake and Precursor* (hlm. 153–158). Research and Development Center, BMKG.

Monalisa, S. S., Djauhari, R., Catarina, S., & Wirabakti, M. C. (2022). Pengaruh pemberian daun papaya (*Carica papaya* L) terhadap kinerja pertumbuhan ikan gurami (*Osphronemus gouramy*) dan parameter fisika kimia air. *Jurnal Akuakultur Sungai dan Danau*, 7(1), 13–21. https://doi.org/10.33087/akuakultur.v7i1.125

Muarif. (2016). Characteristics of water temperature in aquaculture pond. *Jurnal Mina Sains*, 2(2), 96–101.

Pitaloka, T. O., Saidy, A. R., & Yusran, F. H. (2024). Peningkatan pH dengan pemberian bahan organik pada pengelolaan air asam tambang menggunakan metode passive treatment. *Acta Solum*, 2(1), 13–20. https://doi.org/10.20527/actasolum.v2i1.2275

Puspitasari, D., & Purnomo, N. A. (2020). Kajian kesesuaian kualitas air untuk budidaya ikan gurame di Desa Ngranti Kecamatan Boyolangu Kabupaten Tulungagung. *Jurnal Pendidikan Geografi: Swara Bhumi*, 5(9), 1–7.

Ridho'i, A., Setyadjit, K., & Hariadi, B. (2022). Pengaruh suhu dan kejernihan air pada kolam terpal pembesaran ikan nila memanfaatkan ATmega328. *Jurnal Teknik Industri*, 25(1), 38–51.

Rochyani, N. (2018). Analisis karakteristik lingkungan air dan kolam dalam mendukung budidaya ikan. *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan*, 13(1), 51–56. https://doi.org/10.31851/jipbp.v13i1.2856

Tambunan, F. R., Aryani, N., & Heltonika, B. (2025). Evaluation of omega-3 enrichment in commercial feed for gourami (*Osphronemus gouramy* L.) fingerlings. *Acta Aquatica: Aquatic Sciences Journal*, 1(1), 100–105. https://doi.org/10.29103/aa.v1i1.16154

Yanuhar, U., Musa, M., Evanuarini, H., Wuragil, D. K., & Permata, F. S. (2022). Water quality in koi fish (*Cyprinus carpio*) concrete ponds with filtration in Nglegok District, Blitar Regency. *Universal Journal of Agricultural Research*, 10(6), 814–820. https://doi.org/10.13189/ujar.2022.100619