Growth performance of selected and non-selected black tiger shrimp (*Penaeus monodon*) on pond cultivation

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Abstract. This study will compare the growth rates of selected and non-selected tiger shrimp in pond cultivation. This study was carried out in four 2000-square-meter ponds in the experimental shrimp pond in Takalar Regency, South Sulawesi. The study used two treatments: selected tiger shrimp (A) and non-selected tiger shrimp (B). Tiger shrimp weighing 16.33 to 16.85 g were stocked at 0.5 individuals per m^{-2} and cultured for 90 days. During cultivation, these shrimps were administered commercial pelleted feed containing a protein dose of 36-38% (3-5%/body weight), applied twice daily, in the morning and evening. The variables observed were growth, coefficient of variation, survival rate, response selection, and water quality. The findings indicated that the selected black tiger shrimp exhibited superior growth performance compared to the non-selected black tiger shrimp. The weight gain of selected tiger shrimp was 13.96 g, with a specific growth rate of 0.67%.day^{-1}, coefficient of variation of 22.83%, and survival rate of 77.50%. This value is higher by 14.66% in the weight character and 13.30% in the survival rate character compared to non-selected.

1 Introduction

Tiger shrimp (*Penaeus monodon*) is a highly prized species among cultivated shrimp, especially in Asia, and is widely used in coastal aquaculture in many countries. Tiger shrimps are selected in these regions because of their abundant supply, rapid growth, strong durability, and high market-worth [1]. Tiger prawn production techniques are commonly categorized into extensive, semi-intensive, or intense cultures. The extensive and semi-intensive systems rely solely on the intrinsic productivity and richness of pond ecosystems, whereas intensive systems necessitate additional inputs and capital [2].

Tiger shrimp, an indigenous species, is extensively farmed in brackish water ponds throughout Indonesia. Some efforts were focused on disease prevention and increasing growth performance to increase the production of tiger shrimp. Shrimp growth performance can be increased through a growth-based selection program.

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Selection is a breeding technique used to bring together high-quality strains, and it has been widely used in many aquaculture products [3]. The primary objective is to achieve exceptional performance in growth qualities, specifically productivity. Additionally, there is a focus on other significant economic features including disease resistance, stress tolerance, meat quality, and reproductive factors [4]. Selective breeding for enhanced growth characteristics has been implemented across a wide range of global commodities [5]. A concurrent selection process was used to generate the GFP strain (3rd generation) of female giant prawn, focusing on standard length (SL) and maturity level (ML) characteristics. This resulted in a strain with increased productivity [6]. Individual and family selection in Common carp have been reported [7]. Animal breeding efforts now aim to enhance both traits and reduce phenotypic variation. An effective method to attain uniformity is by selectively breeding for decreased residual (environmental) variance, provided that this feature is genetically influenced [8]. The process of domestication, combined with selective breeding, led to significant enhancements in the development of domesticated *P. monodon* over multiple generations.

The Malaysian program experienced a growth rate of 7.3-13%, whereas the program in Madagascar saw a growth rate of 15%. In commercial prawn farms, the domesticated *P. monodon* stock exhibited superior growth, increased harvest yield, and a reduced maturation period compared to the non-domesticated *P. monodon* stock under intense farming conditions [9]. The selection principle is based on the notion that the average genetic value of the selected individuals surpasses the average genetic value of all individuals in the population. This leads to kids with superior genetic value compared to the individuals in the original population [10]. This superiority is anticipated to manifest in all aspects of the tiger shrimp's existence, positively influencing the growth in productivity and corporate profitability.

The cultural significance of the black tiger shrimp, *P. monodon*, is widely recognized because of its exceptional production performance and economic feasibility. The growth, productivity, and viability of cultured species, such as prawns, are affected by the particular culture technique utilized, including extensive or semi-intensive approaches. The physicochemical characteristics of the culture pond, as well as their individual and combined effects, are crucial factors that influence prawn production and the overall ecological equilibrium of the pond. The production performance of shrimp culture may be influenced by the environment and biota of the culture pond.

Several essential measures have been implemented to enhance the productivity of tiger shrimp production and establish a productive and competitive system, including ensuring the supply of high-quality broodstock and seeds. Farmers consistently seek shrimp with rapid growth and strong immunity, which can thrive in many water conditions and enable intensive cultivation at high densities. The research purpose is to compare the growth performance of black tiger shrimp (*Penaeus monodon*) that underwent selection and non-selection, during pond cultivation.

2 Materials and methods

The study was performed at the Experimental Pond Installation, in Punaga Village, Takalar Regency, South Sulawesi, Indonesia, which is located 5°33’4” S to 5°33’10” S and 119°25’19” E to 119°25’24” E

The study was carried out in four ponds, each measuring 2000 m^2, located in the experimental shrimp pond in Takalar Regency, South Sulawesi. The study consisted of two treatments, namely selected tiger shrimp (A) and non-selected tiger shrimp (B). A total of 16.33 to 16.85 grams of tiger shrimp were placed at densities of 0.5 individuals per square meter and a rearing duration of 90 days. During the process of grow-out these shrimps, they

were given commercial pelleted feed containing 36-38% protein, at a dose of 3-5% of their body weight. The feeding regimen consisted of two daily meals, in the morning and evening.

The measured variables encompass absolute weight growth, growth rate, coefficient of variation, the survival of shrimp, response selection, and water quality (salinity, pH, temperature, dissolved oxygen (DO), NO_3, PO_4, and total organic matter).

Absolute Weight Growth

The weight gain can be calculated using the formula [11],

$$B = Bt - Bo \quad (1)$$

where:
B = Weight growth (g)
Bt = Final average weight of shrimp during rearing (g)
Bo = Initial average weight of shrimp during rearing (g)

Specific growth rate (SGR)

The specific growth rate can be calculated using the formula [11]:

$$SGR = \frac{Ln\,Wt - Ln\,Wo}{t}\ x\ 100 \quad (2)$$

Where:
SGR: Specific growth rate (% day^{-1})
Wt: Final average weight of shrimp maintenance (g)
Wo: Initial average weight of shrimp during maintenance (g)
t: Duration of maintenance (days)

Coefficient of variation

The coefficient of variation is calculated using the formula [12]:

$$CV\ (\%) = \frac{S}{X} x\ 100 \quad (3)$$

where:
CV: Coefficient of variation
S: Standard deviation
X: Average

Survival Rate

The survival rate can be calculated using the formula [11]:

$$Survival\ rate\ (\%) = \frac{Nt}{No} x\ 100 \quad (4)$$

where:
Nt = Final quantity of shrimp during maintenance (ind)
No = Initial quantity of shrimp during maintenance (ind)

The data on tiger shrimp growth and survival rate were analyzed using t-student in the SPSS program version 25.00, and the coefficient of variation water quality data were analyzed descriptively.

3 Results

3.1. Growth performance of tiger shrimp (*P. monodon*)

The observed growth of tiger shrimp weight throughout 90 days of maintenance rose in tandem with the increase in maintenance period for all treatments (Fig.1). The mean weight of the selected tiger shrimps was 30.81 g per individual, with a weight increase of 13.961 grams per individual (83%). In contrast, the non-selected tiger shrimps grew at 26.87 grams per individual, with a weight rise of 10.54 grams per individual (65%). The weight increase seen in this study did not exhibit any statistically significant deviation from previous investigations. Researchers noted a substantial 95% growth in the weight of tiger shrimps during a span of 220 days, almost equivalent to 7.3 months [13]. The female tiger shrimps saw a weight increase of 98.5%, while male tiger shrimps had a weight rise of 98.13% after 120 days of pond cultivation [14]. The adult female black tiger shrimp exhibited a weight range of 79.7-87.8 g per individual, with a corresponding weight rise range of 35.8-46.4 grams (equivalent to 81.55-112.08% increase). The tiger shrimp has a weight range of 65.5-66.0 grams per individual and a weight gain range of 32.3 to 33.3 (equivalent to 97.29-101.83%) after 165 days of culture in a recirculation tank [15].

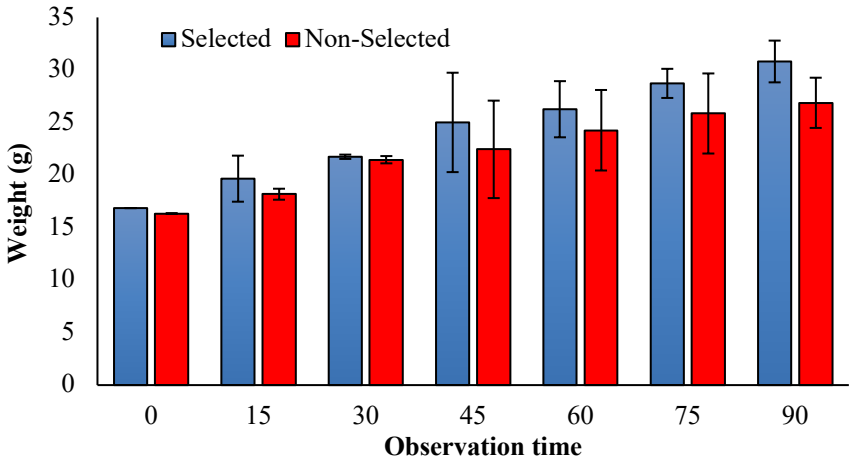

Fig. 1. Growth performance of selected and non-selected tiger shrimp (*P. monodon*) during the experiment

The value of weight gain of selected tiger shrimp was 13.96 g, with a specific growth rate of 0.67% day^{-1}, Meanwhile, in non-selected tiger shrimp, the weight gain was 10.54 g with a particular rate of growth of 0.55% day^{-1}. This value is higher in weight growth performance (14.66%) than non-selected shrimp (Table 1). Moreover, curated populations of *P. japonicus* have been shown to exceed the performance of non-selected stocks in commercial pond environments. The results indicated that *P. japonicus* stocks were first selected for their fast growth in aquaculture ponds. The selected stocks gained significant weight during the initial harvest. The mean weight at the initial harvest of G2 stocks exhibited a 9.3% increase relative to the progeny of wild stocks, while H4 stocks showed a 14% increase [16]. The semi-intensive culture system has an average growth rate of 0.34 g per day [17]. The growth performance attained in this study is similar to that of previous studies conducted. The Fo generation tiger shrimps had a daily growth rate of 0.42 ± 0.04 g/day, whereas the F1 generation displayed a growth rate of 0.35 ± 0.36 g/day [18].

The growth rates of transfected and non-transfected black tiger shrimp were 0.13 grams per day and 0.15 grams per day, respectively [19]. The growth and development of domesticated tiger shrimp varied among different farms, depending on the environmental conditions and the skill of the farmer. Vung Tau agricultural estate demonstrated the most positive outcomes, with the highest growth rate (0.21 to 0.24 gram per day), leading to a yield of 31g-shrimp after a culture period of 120-130 days. In addition, the survival rate exhibited a favorable range of 74% to 81%. On the other hand, the second pond with wild tiger shrimp exhibited reduced growth (0.17 g per day), smaller shrimp (51 individuals per kg), and a survival rate of 67% [20].

Table 1. The growth performance and survival rate of both selected and non-selected black tiger shrimp were observed over a 90-day culture period.

Variables	Tiger Shrimp (*Penaeus monodon*)	
	Selected	**Non-Selected**
Initial weight (g)	16.85±5.68	16.33±5.45
Final weight (g)	30.81±1.98	26.87±2.39
Absolute weight (g)	13.96±1.98 ^{b}	10.54±2.39 ^{a}
Specific Growth Rate (%/day)	0.67±0.07 ^{a}	0.55±0.09 ^{a}
Coefficient Variation (%)	22.83±0.00^{a}	20.86±0.00^{a}
Survival rate (%)	77.50±1.10 ^{b}	68.40±1.10 ^{a}

Average growth rate of cultured shrimps was found to be 0.20 g per day to 0.23 g per day in the culture pond with probiotics and without probiotics, respectively [21]. The mean growth rates of black tiger shrimps cultivated with various feeding methods over a period of 90 days were as follows: T0 (100% Commercial Feed) had a growth rate of 1.93%, T1 (aqua mimicry, 10% LFRB + 90% Commercial Feed) had a growth rate of 2.1%, and T2 (aqua mimicry, 30% LFRB + 70% Commercial Feed) had a growth rate of 3.07% [11]. The tiger shrimp that were collected had an average ultimate body weight of 37.67 1.15 g in the probiotics tank and 27.33 0.58 g in the control pond. In the probiotics pond, the average daily weight growth was 0.27 ± 0.01 g, while in the control pond it was 0.19 ± 0.01 g. The shrimp were cultured for 138 days at densities of 13 individuals per square meter [22]. Using a diet consisting of 35% crude protein and a concentration of 10 mlL^{-1} bio floc resulted in an absolute growth of 17.21 g, daily growth rate of 0.58 grams per day, specific growth rate of 3.53% per day, survival rate of 100%, feed conversion ratio (FCR) of 0.974, and a feed efficiency of 102.7% [23]. The growth rate of tiger shrimp displayed considerable variance, ranging from 0.11 to 0.36 grams per day. The growth rate of the domesticated *Penaeus monodon* stock was 0.17 to 0.21 grams per day in the two ponds at the Vung Tau 2 farm. The growth rate observed in the Vung Tau 1 farm in the pond was 0.24 grams per day. The growth rates at the Soc Trang farm were 0.197 ± 0.008 grams per day for the domesticated stock and 0.165 ± 0.008 g per day for the non-domesticated animals [9].

The performance of tiger shrimp was observed after 91 days of culture at various stocking densities (4, 6, and 8) in a mangrove reservoir under high water salinity conditions. The shrimp's final weight was documented as 14.7 g, 15.8 g, and 8.9 g, respectively. The daily growth rate was recorded as 0.163 grams per day, 0.175 grams per day, and 0.098 grams per day, respectively [24]. The specific growth rate initially showed a phase of elevated values for the entire culture time, which was subsequently followed by a gradual decline as the experiment advanced. Similarly, the mortality rate was originally high during the first month

of cultivation but then reduced to a lesser level. Moreover, a higher stocking density requires a larger quantity of food inputs, leading to the production of additional waste [25].

The diminished daily growth rate of shrimps can be ascribed to a range of interconnected elements, such as water quality, abundance of natural food, stocking density, and other environmental variables. A negative correlation was observed between the prawn density in a specific location and their growth rate [20]. The growth of shrimp is contingent not alone upon the quantity of shrimp stocked, but also upon the execution of efficacious management strategies [17]. The growth of shrimp is contingent not alone upon the quantity of shrimp stocked, but also upon the execution of efficient management techniques. The biodiversity and natural food availability in aquaculture ponds are crucial sources of nutrition for shrimp, particularly in the initial stages of their growth [26].

3.2. Coefficient variation of body weight tiger shrimp (*P. monodon*)

The Coefficient variation (CV) of body weight of the selected tiger shrimp was 22.83%, whereas for the non-selected shrimp, it was 20.86% (Tabel 1). This suggests that around 77% of the shrimps that were caught have a consistent and similar weight. The degree of consistency in shrimp size serves as an indicator of the quality of shrimp and the shrimp yield obtained during harvest. The uniform size will reduce the level of feed competition and shrimp dominance in obtaining space, feed, and oxygen. The smaller the coefficient of diversity, the better the quality of the shrimp produced and the higher the selling value. The CV for the body weight of tiger shrimp from ponds with varied fry origins ranges from 18.57% to 24.43%. However, the coefficient of variation for the weight of tiger shrimp from ponds with fry originating from nature is 22.14%. Weight fluctuation can be affected by different environmental conditions, including stocking density and the duration of maintenance or age. Weight variation at low stocking density (<10,000 ind/ha) is 23.99% higher than at stocking density of more than 10,000 ind/ha with a coefficient of variation reaching 21.39% [27]. The coefficient of variation of shrimp weight obtained in this study is comparable to that of earlier investigations.

The weight of white shrimps from super-intensive pond farming exhibits a coefficient of variance ranging from 12.7% to 14.6% [28]. The variation in size of white shrimp directly impacts the overall quality of the shrimp. A coefficient of variation of 15% or less indicates low size variation, whereas a coefficient of variation between 15% and 25% indicates medium size variation. A coefficient of variation greater than 25% indicates significant size variation [29]. The coefficient of variation for body weight in the selected *Macrobrachium rosenbergii* giant freshwater prawn during the nursery phase was 38.15%, while in the non-selected control populations, it was 41.33%. [6]. To assess the diversity of a character, the following criteria are employed: if the coefficient of variation falls within the range of 0-20%, it is considered low; if it falls within the range of 20-50%, it is considered medium; and if it exceeds 50%, it is considered high. The coefficient of variation quantifies the level of variability present in a population. A larger coefficient of variation signifies increased diversity or heterogeneity within the population, whereas a lower coefficient of variation indicates reduced diversity or homogeneity [30].

Significant differences in body size can cause shrimp to compete with one another, leading to the establishment of dominance hierarchies. These hierarchies can negatively impact the growth, mortality, and feed efficiency of the shrimp. This necessitates the implementation of management measures, such as size grading, to address these issues. Enhancing uniformity has the potential to enhance resilience, which refers to an animal's ability to retain performance despite environmental disturbances [31]. The significant genetic link between weight and growth highlights the necessity of integrating weight uniformity into shrimp breeding techniques [8].

The impacts described are particularly noticeable in aquaculture species because of the increased proximity between individuals in this production setting. However, it has been observed that high birthweight variation in piglets is already linked to mortality and competition from birth to weaning [32]. The presence of genetic variation for weight uniformity indicates the potential for genetic enhancement of this characteristic. Weight uniformity selection should not result in weight reduction, as there is a minor genetic link between these two qualities. The strong genetic correlation of weight uniformity between the two environments indicates that if the breeding objective includes this trait, the progress made in selecting for uniformity in the nucleus will be partially conveyed to the commercial population [8].

3.3. Survival rate of tiger shrimp (*P. monodon*)

In the current study, the survival rate of the selected tiger shrimp was 77.50%, whereas the survival rate of the non-selected shrimp was 68.40%. The survival rate of selected shrimp is 13.30% higher than that of non-selected shrimp (Table 1). The survival rate of tiger shrimp observed in this research was not superior to that of various prior investigations. The F0 generation of tiger shrimp exhibited a survival rate of 73.35±2.05%, and the F1 generation demonstrated survival of 51.0 ±31.68% [18]. The survival percentage of tiger shrimp, which were raised using Specific Pathogen Free shrimp, and stocked in a 1,600-square meter pond at a density of 4-8 individuals per square meter for 8 months, was found to be a mere 30% [9]. The survival rate of the selected *Macrobrachium rosenbergii*, a type of large freshwater shrimp, throughout the grow-out phase was 70.5±13.3%. In comparison, the survival rate of non-selected shrimp in the control populations was 62.8±18.44% [6]. Tiger shrimp survival rates in semi-intensive and extensive culture systems were 65.11.9% and 49.24%, respectively. The survival rate is contingent upon various parameters, including water quality, Gher ecology, feed ingredients, and feeding rate [33]. The survival of tiger shrimp during harvest in the dry season ranges from 27.57% to 66.67%; with mean weight of 14.29-40.00 g per individual [34]. After the 11th week of stocking, T2 and T1 exhibited markedly higher shrimp survival rates compared to T0 (1%). The proportions for control T0 (100% CF), T1 (aqua mimicry, 10% LFRB + 90% CF), and T2 (aqua mimicry, 30% LFRB + 70% CF) were 1.0%, 45%, and 55%, respectively [11].

The tiger shrimp survival rate in probiotics pools was 90.67%, but in control ponds, it was 71.00%. The observation occurred 138 days into the culture, with a population density of 13 individuals per square meter [22]. The pond treated with probiotics had a survival rate of 64.13 ± 12.63%, while the pond without probiotics had a survival rate of 44.17 ± 14.15%. The pond treated with probiotics produced an average of 208 ± 46 kg per pond per cycle, while the pond under controlled conditions produced an average of 123 ± 6 kg per pond per cycle. The findings demonstrated that probiotics had a significant impact on maintaining water quality indicators and regulating health, while also enhancing the survival rate of prawns. The tiger prawns in the probiotic ponds achieved a final weight of 16.2 g per individual and had a specific growth rate of 0.03 g per day. The tiger shrimp in the control ponds, devoid of probiotics, demonstrated a final weight of 15.6 g per individual and a specific growth rate of 0.04 g per day [35]. Supplementing with probiotics enhances the survival, SGR, and FCR of penaeid shrimps [36]. The survival rate of tiger shrimp in integrated culture with seaweed and blood cockle ranges from 86.331.15% to 90.330.58% [21]. The cultivation of tiger shrimp survival is enhanced by feeding them with S. androgynous leaf extract, resulting in a feed range of 44.66% to 57.33% [37].

Several conditions and circumstances influence the shrimp's survival. Several key factors, including shrimp density, environmental circumstances, water quality, and the type and amount of food, affect shrimp growth and development. Shrimp can flourish and prosper

in regions characterized by favorable water quality and an ample food supply. Additionally, it is important to take into account the duration of shrimp cultivation as shrimp tend to engage in cannibalism, which has a direct impact on their ability to survive and thrive. Keeping the juveniles longer will result in a corresponding increase in the prawn biomass's weight. This will result in intensified competition for resources including space, nutrients, and oxygen, thereby diminishing seed survival rates and water quality. Furthermore, there is a prevalent agreement that size disparities significantly impact the survival rates of shrimp [38]–[40].

3.4. Water Quality

The growth and sustainability of produced tiger shrimp are significantly influenced by water quality. During the entire study period, we assessed several physicochemical parameters including temperature, pH, salinity, dissolved oxygen (DO), Nitrate, phosphate, and total organic matter (TOM) are detailed in Table 2.

Table 2. The range of water quality variables measured during the experiment

Variables	Tiger Shrimp (*Penaeus monodon*)	
	Selected	**Non-Selected**
Temperature (^{0}C)	24.70 - 33.20	24.50 - 34.30
pH	7.17 - 8.73	7.18 - 8.69
Salinity (ppt)	38.35 – 43.98	39.28 – 44.57
Dissolved Oxygen (mg/L)	2.35 – 6.67	2.18 – 7.18
NO_3-N (mg/L)	0.0215-0.0798	0.0831-0.1438
PO_4-P (mg/L)	0.0021-0.2351	0.0021-0.3035
TOM (mg/L)	47.55-50.60	48.80-56.39

Water quality assessments while cultivating both selected and non-selected tiger shrimp. The temperature varied between 24.50 to 34.30 ºC, the pH levels between 7.17 to 8.73, the salinity levels between 38.35 to 44.57 parts per thousand, and the DO levels between 2.18 to 7.18 mg/L. The water quality assessed during the experiment remained within allowed parameters for tiger shrimp production. The water quality parameter values are not different from several previous studies.

Water quality observations during the semi-intensive and extensive systems of tiger shrimp were DO 6.5-7.7 mg/L, pH 7.3-8.5, salinity 3-5 ppt, alkalinity 99-140 mg/L, temperature 33-34 ^{0}C, and the watercolor was green and light green [33]. Tiger shrimp were cultivation for 90 days, and they were as follows: The pH from 7.79 to 8.11, salinity from 5.37 to 5.67 ppt, alkalinity from 74.37 to 78.75 mg/L, temperature from 31.8 to 33.3 ^{0}C, DO from 5.74 to 6.01 mg/L, and transparency from 48 to 54 cm. [11]. The dissolved oxygen level (6.8–10.3 mg/L), pH level (7.22–8.44), temperature range (30–32ºC), salinity level (16.0-28.2), total suspended solids level (0.10-0.17 gram per L), biological oxygen demand (BOD) level (0.15-0.25 mg/L), chlorophyll a level (50–250 mg/m^3), NO_3 level (0.002-0.01 mg/L), and PO_4 level (0.0-0.16 mg/L) were all in the right range for tiger shrimp to grow. The shrimp exhibited no signs of stress under these conditions [20].

The water quality metrics include dissolved oxygen levels ranging from 6.8 to 10.3 mg/l, pH levels ranging from 7.22 to 8.44, temperature ranging from 30 to 32ºC, salinity ranging from 16.0 to 28.2‰, total suspended solids ranging from 0.10 to 0.17 g/L, biological oxygen demand spanning from 0.15 to 0.25 mg/L, chlorophyll levels spanning from 50 to 250 mg/m^3, NO_3 levels between 0.002 to 0.01 mg/L, and PO_4 levels between 0.0 to 0.16 mg/L. We

conducted water quality assessments while cultivating tiger shrimp in a conventional pond. The cultivar used *Boesenbergia pandurata* and *Solanum ferox* extract as feed supplements. The temperature varied between 18 to 30ºC, the dissolved oxygen levels between 4.0 to 5.0 mg/L, the pH levels spanning from 5.5 to 8.0, the salinity levels spanning from 15 to 25 parts per thousand, and the pyrite levels between 1.42% to 2.98% [41]. The water quality attributes of tiger shrimp cultivation ponds were as follows: The temperature varied between 26 to 30ºC, the dissolved oxygen levels spanning from 4.5 to 5.5 mg/L, the pH levels spanning from 7.6 to 8.2, the salinity levels spanning from 13 to 28 parts per thousand, the transparency levels ranged from 38 to 55 cm, and the ammonia levels spanning from 0.1 to 0.3 mg/L. Salinity is crucial in regulating the growth and survival of shrimp.

Although *P. monodon* is capable of tolerating a wide range of salt levels, it flourishes under conditions of ideal salinity. Shrimps experience a decrease in development rate when exposed to high levels of salinity, yet they demonstrate strong health and an improved ability to withstand diseases. Inadequate salt levels could result in a delicate shell that is susceptible to infection. We constantly maintained the salinity level in the culture pond for this investigation within the range of 24 to 30 parts per thousand (ppt) [42]. The optimal salinity range for *P. monodon* cultivation is 10 to 35 parts per thousand (ppt). Despite being a euryhaline aquatic species, *P. monodon*. In the presence of high salt, the shrimp's development rate decreases. However, it remains in a healthy state and shows resistance to illnesses [43]

The water quality parameters observed during tiger shrimp production in an integrated culture system with seaweed and blood cockle were as follows: Temperature ranged from 26.2 to 32 ºC, pH was 7.28 to 8.30 in range, salinity between 23 to 27 parts per thousand (ppt), and dissolved oxygen (DO) levels with range 3.10 to 6.90 mg/L [21]. The average values of physico-chemical parameters of water at three stations in the Karang Gading estuary, South Sumatera, where tiger shrimp are cultivated, have a temperature range of 30.0 to 32 °C. The luminosity of the water corresponds to a span of 25 to 81 centimeters. The water depth varies between 1.31 and 4.5 meters. The pH level is between 4.33 to 6.59. The salinity is between 12 to 27 parts per thousand (‰). The dissolved oxygen (DO) is between 1.9 to 3 milligrams per liter (mg/L). The nitrate levels 0.01 to 0.04 mg/L range. The BOD_5 (biochemical oxygen demand) is between 0.1 to 2.1 mg/L. The phosphate levels 0.03 to 0.2 mg/L. The water quality during tiger shrimp production in the integrated culture system with seaweed and blood cockle was characterized by a temperature range of 26.2 to 32 degrees Celsius, a pH is between of 7.28 to 8.30, a salinity is between of 23 to 27 parts per thousand (ppt), and dissolved oxygen (DO) values is between 3.10 to 6.90 milligrams per liter (mg/L) [44].

Exsitu water quality parameter values during the research, namely nitrate levels is between 0.0215-0.1438 mg/L, and phosphate levels is between 0.0021-0.3035 mg/L. Nitrate is the primary nitrogen compound found in natural bodies of water and is crucial for the growth of aquatic organisms, particularly algae. It is very soluble in water and demonstrates stability. The optimal nitrate concentration required for the proliferation of algae in waterfalls is within the is between of 0.2 to 0.9 mg/L, with the ideal range being 0.1 to 4.5 mg/L. The advised phosphate content (PO4-P) range for shrimp aquaculture is 0.05–0.5 mg/L. Elevated concentrations of dissolved inorganic phosphate (1.0 ± 0.0 mg/L) during the culture phase can hinder prawn growth and prolong the harvesting period [45].

Organic materials in the pond's soil can indicate the land's fertility. creatures inhabiting pond water rely on organic matter for their survival. However, an excessive amount of total organic matter can facilitate the growth and spread of detrimental creatures including parasites, bacteria, and viruses. However, an excessive amount of total organic matter can facilitate the growth and spread of detrimental creatures including parasites, bacteria, and viruses. To maintain the health of farmed shrimp and fish, it is essential to limit the levels of

organic matter, ammonia-nitrogen, and nitrite-nitrogen. Aquatic creatures recognize these chemicals as harmful.[46]. The ideal range of total organic matter in tiger shrimp culture, when employing extensive and semi-intensive procedures, is between 55 to 90 milligrams per liter [47].

4 Conclusions

The selected tiger shrimp outperformed the non-selected black tiger shrimp's growth performance. The black tiger shrimp exhibited a weight gain of 13.96 g, a specific growth rate of 0.67% per day, a coefficient of variation of 22.83%, and a survival rate of 77.50%. The weight character of the selected tiger shrimp is 14.66% higher, and the survival rate character is 13.30% higher, compared to the non-selected tiger shrimp.

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References

1. P. Muangyao, K. Fukami, P. Songsangjinda, Y. Predalumpaburt, Stimulation by gutweed to increase the abundance of insect larvae as food for shrimp aquaculture in Thailand. Aquaculture. **519**, 734740 (2020). https://doi.org/10.1016/j.aquaculture.2019.734740
2. J. Reis, R. Novriadi, A. Swanepoel, G. Jingping, M. Rhodes, D.A. Davis, Optimizing feed automation: improving timer-feeders and on-demand systems in semi-intensive pond culture of shrimp *Litopenaeus vannamei.* Aquaculture. **519**, 734759 (2020), https://doi.org/10.1016/j.aquaculture.2019.734759
3. T. Gjedrem, N. Robinson, M. Rye, The importance of selective breeding in aquaculture to meet future demands for animal protein: A review. Aquaculture. **350–353**, 17–129, (2012). https://doi.org/10.1016/j.aquaculture.2012.04.008
4. T. Gjedrem, N. Robinson, Advances by selective breeding for aquatic species: a review, Agric. Sci. **5**, 12, 1152–1158 (2014). https://doi.org/10.4236/as.2014.512125
5. T. Gjedrem, M. Rye, Selection response in fish and shellfish: a review. Rev. Aquac. **10** 1, 168–179 (2016). https://doi.org/10.1111/raq.12154
6. I. Khasani, A. Sopian, Growth, survival, and production performance of the selected giant freshwater prawn, *Macrobrachium rosenbergii* in three farming stages. Media Akuakultur. **16**, 2, 57 (2021). https://doi.org/10.15578/ma.16.2.2021.57-64
7. D. Ariyanto, The right selection method for great selected result. Media Akuakultur. **10** 2, 65 (2015). https://doi.org/10.15578/ma.10.2.2015.65-70
8. S. García-Ballesteros, B. Villanueva, J. Fernández, J. P. Gutiérrez, I. Cervantes, Genetic parameters for uniformity of harvest weight in Pacific white shrimp (*Litopenaeus vannamei*). Genet. Sel. Evol. **53**, 1, 1–9 (2021). https://doi.org/10.1186/s12711-021-00621-6
9. N.D. Hoa, Domestication of black tiger shrimp (*Penaeus monodon*) in recirculation systems in Vietnam. PhD. thesis, Ghent University, Belgium (2009)

10. D. Hung, Genetic improvement of giant freshwater prawn in Vietnam, PhD thesis, Earth, Environmental and Biological Sciences Science and Engineering Faculty Queensland University of TechnologyBrisbane, Australia, p.151 (2013)
11. S. Islam, M. Das, K. Chakraborty, J. Min, Aquamimicry improves the growth performance and immunity of black tiger shrimp (*Penaeus monodon*) in low saline ponds. Aquac Reports. **36,** 102082 (2024). https://doi.org/10.1016/j.aqrep.2024.102082
12. W. Firmansyah, N. Cokrowati, A.R. Scabra, The Effect of different size recirculation systems on the quality of water in Tilapia (*Oreochromis niloticus*) Culture. J. Perikan. dan Kelaut. **26**, 2, 85–93 (2021)
13. A. Laining, U. Usman, M. Muslimin, N.N. Palinggi, Growth and reproductive performance of pond reared tiger shrimp fed different combinations of maturation diet, J. Ris. Akuakultur. **9**, 1, 67 (2014). https://doi.org/10.15578/jra.9.1.2014.67-77
14. S. Tonnek, M.N. Syafaat, H. Haryanti, Growth of tiger shrimp larvae fast growing strains and selection of candidate broodstock originated from pond. Prosiding Forum Inovasi Teknologi Akuakultur 2015, pp. 979–983 (2015)
15. S. Lante, Effect of female and male ratio on mating success of *Penaeus monodon* tiger shrimp in recirculation tanks. J. Ilmu Alam dan Lingkung. 8, 16, 52–57 (2017)
16. N.P. Preston, P.J. Crocos, S.J. Keys, G.J. Coman, R. Koenig, Comparative growth of selected and non-selected Kuruma shrimp Penaeus (Marsupenaeus) japonicus in commercial farm ponds; implications for broodstock production. Aquaculture. **231**, 73–82 (2004). https://doi.org/10.1016/j.aquaculture.2003.09.039.
17. P. Janakiram, L. Jayasree, R. Madhavi, Survival, growth, and production of Penaeus monodon in modified-extensive and semi-intensive culture systems of Andhra Pradesh, India, Asian J. Exp. Sci. **25**, 2, 53–61 (2011)
18. H.S. Suwoyo, S. Sahabuddin, Growth performance of transfection tiger shrimp broodstock *Penaeus monodon* in different generation. J. Ilmu dan Teknol. Kelaut. Trop. **9,** (1) 185–200 (2017)
19. H.S. Suwoyo, S. Sahabuddin, A. Sahrijanna, E. Septiningsih, S.R.H. Mulyaningrum, Grow-out of transfection and non-transfection black tiger shrimp broodstock, *Penaeus monodon* in concrete pond, IOP Conf. Series: Earth and Environmental Science 584 (2020) 012015, (2020), https://doi.org/10.1088/1755-1315/584/1/012015
20. A. Hena, M. Kamal, U.M. Terengganu, S. Sharifuzzaman, Pond Health management of black tiger shrimp *Penaeus monodon* (Fabricius) using bacterial products, in Bondad-Reantaso, M.G., Mohan, C.V., Crumlish, M. and Subasinghe, R.P. (eds.). Diseases in Asian Aquaculture VI. Fish Health Section, Asian Fisheries Society, Manila, Philippines, pp. 469–476, (2008)
21. R. Amalia, S.R.I. Rejeki, L.L. Widowati, R.W. Ariyati, The growth of tiger shrimp (*Penaeus monodon*) and its dynamics of water quality in integrated culture', Biodiversitas. **23**, 1, 593–600 (2022). https://doi.org/10.13057/biodiv/d230164.
22. M.I. Hossain, M.M. Kamal, M.A. Mannan, M.A.B. Bhuyain, M.I. Hossain, Effects of Probiotics on Growth and Survival of Shrimp (*Penaeus monodon*) in Coastal Pond at Khulna, Bangladesh. J. Sci. Res. **5**, 2, 363–370 (2013). https://doi.org/10.3329/jsr.v5i2.11815.
23. A. Supriatna, N. Nurhatijah, M.A. Sarong, Z.A. Muchlisin, Effect of biofloc density and crude protein level in the diet on the growth performance, survival rate, and feed conversion ratio of Black Tiger Prawn (*Penaeus monodon*), ICFAES 2019 IOP Conf.

Series: Earth and Environmental Science 348 (2019) 012131, (2019). https://doi.org/10.1088/1755-1315/348/1/012131

24. G. Gunarto, M. Muslimin, M. Atmomarsono, Tiger shrimp (*Penaeus monodon*) growth at different stocking densities in high salinity pond using mangrove reservoir, Indones. Aquac. J. **1**, 1, 1–7 (2006)
25. C. Folke, N. Kautsky, Aquaculture with its environment: Prospects for sustainability. Ocean Coast. Manag. **17**, 1, 5–24 (1992). https://doi.org/10.1016/0964-5691(92)90059-T.
26. M.H. Abualreesh, Biodiversity and contribution of natural foods in tiger shrimp (*Penaeus monodon*) aquaculture pond system : a review. AACL Bioflux. **14**, 3, 1715–1726 (2021).
27. F. Cholik, M.A, Weight diversity of tiger shrimp cultivated in ponds in Maros and Pangkep Regencies, South Sulawesi. J. Penelit. Budid. Pantai. **3**, 1, 22-27 (1987)
28. H.S. Suwoyo, M. Makmur, T. Suwardi, Diversity of vaname shrimp harvest (*Litopenaeus vannamei*) in super intensive pond. Prosiding Seminar Nasional Kelautan dan Perikanan XIV, Fakultas Pertanian, Departemen Perikanan, Universitas Gadjah Mada, pp. 1–9 (2014)
29. A.M. Halim, N. Nasuki, P.D. Purnama, Technical Study of maintenance of vaname shrimp larvae (*Litopenaeus vannamei*) in Hatchery PT. Nusa Dharma Lautan, Kalipuro District, Banyuwangi Regency, East Java, J. Perikan. Pantura. **7**, 1, 464 (2024). https://doi.org/10.30587/jpp.v7i1.7486.
30. H. Tempake, H.T. Luntungan, Estimation of genetic parameters and correlation between morphological Traits in Coconut (*Cocos nucifera*, Linn). LITTRI. **8**, 3, 97–102 (2002)
31. L.H. de S. Iung, R. Carvalheiro, H.H. de R. Neves, H.A. Mulder, Genetics and genomics of uniformity and resilience in livestock and aquaculture species: a review. J. Anim. Breed. Genet. **137**, 3, 263–280 (2020). https://doi.org/10.1111/jbg.12454
32. B.N. Milligan, D. Fraser, D.L. Kramer, Within-litter birth weight variation in the domestic pig and its relation to pre-weaning survival, weight gain, and variation in weaning weights, Livest. Prod. Sci. **76**, 1–2, 181–191 (2002). https://doi.org/10.1016/S0301-6226(02)00012-X.
33. W. Sabbir, T. Sultana, M.N. Khan, M. Das, S.M.B. Rahaman, Production performance of tiger shrimp (*Penaeus monodon*) in semi-intensive freshwater pond. Int. J. Business. Soc. Sci. Res. **5,** 1, 1–6 (2016)
34. A.A. Mustafa, A.I.J. Asaad, D. Linthin, Tiger shrimp (*Penaeus monodon*) culture performance during dry season in brackishwater pond of Marusu Subdistrict Maros District. Media Akuakultur. **16**, 1, 45 (2021). https://doi.org/10.15578/ma.16.1.2021
35. I. Insan, E.K. Kontara, R. Roro, S. Pudji, S. Dewi, Improved production of tiger shrimp (*Penaeus monodon*) through probiotics application. Indones. Aquac. J. **10**, 2, 131–136 (2015)
36. A. Toledo, L. Frizzo, M. Signorini, P. Bossier, A. Arenal, Impact of probiotics on growth performance and shrimp survival: a meta-analysis, Aquaculture. **500**, 196–205 (2019). https://doi.org/10.1016/j.aquaculture.2018.10.018
37. A. Awaluddin, I.M. Abdiani, A. Ahmad, R. Rukisah, Increasing growth tiger prawn (*Penaeus monodon*) using organic diet of *Sauropus androgynous*. J. Trop. Life Sci. **10**, 3, 253–257 (2020). https://doi.org/10.11594/jtls.10.03.09.

38. S.J. Arnold, F.E. Coman, C.J. Jackson, S.A. Groves, High-intensity, zero water-exchange production of juvenile tiger shrimp, *Penaeus monodon*: An evaluation of artificial substrates and stocking density. Aquaculture. **293**, 1–2, 42–48 (2009). https://doi.org/10.1016/j.aquaculture.2009.03.049
39. S.J. Arnold, M.J. Sellars, P.J. Crocos, G.J. Coman, Intensive production of juvenile tiger shrimp Penaeus monodon: An evaluation of stocking density and artificial substrates. Aquaculture. **261**, 3, 890–896 (2006). https://doi.org/10.1016/j.aquaculture.2006.07.036.
40. G.J. Coman, P.J. Crocos, S.J. Arnold, S.J. Keys, N.P. Preston, B. Murphy, Growth, survival and reproductive performance of domesticated Australian stocks of the giant tiger prawn, *Penaeus monodon*, reared in tanks and raceways. J. World Aquac. Soc. **36,** 4, 464–479 (2005). https://doi.org/10.1111/j.1749-7345.2005.tb00394.x
41. E.H. Hardi et al, Application of phyto-stimulants for growth, survival rate, and meat quality improvement of tiger shrimp (*Penaeus monodon*) maintained in a traditional pond. Pathogens. **11**, 1243 (2022). doi: https:// doi.org/10.3390/pathogens11111243
42. M. Shailenderl, S. Babu, B. Srikath, B. Kishor, D. Silambaran, P. Jayagopal, Sustainable culture method of giant black tiger shrimp, *Penaeus monodon* (Fabricius) in Andhra Pradesh. India. IOSR J. Agric. Vet. Sci. **1**, 3, 12–16 (2012). https://doi.org/10.9790/2380-0131216
43. P. Soundarapandian, V. Ramanan, G.K. Dinakaran, Effect of probiotics on the growth and survival of *Penaeus monodon* (Fabricius). Curr. Res. J. Soc. Sci. **2**, 2, 51–57 (2010)
44. N. Fauziah, M.B. Mulya, T.A. Barus, Density, length-frequency distribution and growth pattern of Penaeus monodon in Karang Gading estuary. AACL Bioflux. 15, 3, 1422–1434 (2022)
45. N.C. Tharavathy, Water quality management in shrimp culture. Acta Biol. Indica. **3**, 1, 536–540 (2014)
46. M. Atmomarsono, E. Susianingsih, Effect of different probiotic bacteria on survival rate, growth, and production of whiteleg shrimp in traditional-plus technology, Indonesia. Aquac. J. **10**, 1, 71–79 (2015)
47. PERMEN-KP-75, Peraturan Kelautan dan Perikanan Republik Indonesia Nomor No.75/PERMEN-KP/2016 Tentang Pedoman Umum Pembesaran Udang Windu (*Penaeus Monodon*) dan Udang Vaname (*Litopenaeus vannamei*). pp. 1–43 (2016)