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THE EFFECT OF DIFFERENT SALINITY ON THE GROWTH AND SURVIVAL OF VANNAMEI SHRIMP (*Litopenaeus vannamei*) IN SUKAMARA REGENCY

Pengaruh Perbedaan Salinitas terhadap Pertumbuhan dan Kelangsungan Hidup Udang Vaname (*Litopenaeus vannamei*) di Kabupaten Sukamara

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ABSTRACT

Vannamei shrimp (*Litopenaeus vannamei*) is one of the world's leading aquaculture commodities. Sukamara Regency is a leading regency for whiteleg shrimp cultivation in Central Kalimantan Province. Vannamei shrimp are euryhaline organisms, meaning they can survive in salinities ranging from 0.5 to 50 ppt, but optimal growth is generally reported to be in the range of 15 to 25 ppt. Shrimp's osmoregulation mechanism allows them to adjust their body's osmotic pressure to the environment, but this process requires extra energy. At salinities outside the optimal range, energy allocated for growth is diverted to maintaining ion balance, thus reducing growth rate. This study aimed to examine the effect of different salinities on the growth and survival of whiteleg shrimp. This research was conducted at the PSDKU Sukamara Fish Farming Laboratory and Workshop over a four-month period, from preparation to data analysis. The method used in this study was a completely randomized design consisting of 3 different salinity treatments and 4 replications. The highest growth performance results were found in P3 (salinity 20 ppt) followed by P2, and P1. While survival did not show any significant difference, with the highest survival rate in P3 treatment at 85%, followed by P1, and P2 at 75%. Water quality parameters showed that the water quality of cultivated fish was still in optimal condition, which showed that the temperature ranged between 26-28 ^{o}C, pH ranged between 7.8-8.2, and DO ranged between 10.4-10.9 mg/L.

Keywords: Vannamei Shrimp, Growth, Survival Rate, Osmoregulation, Different Salinity

ABSTRAK

Udang vanamei (*Litopenaeus vannamei*) merupakan salah satu komoditas akuakultur utama di dunia. Kabupaten Sukamara merupakan Kabupaten unggulan untuk produksi budidaya udang Vannamei di Provinsi Kalimantan Tengah. Udang vanname termasuk dalam organisme euryhaline, artinya mampu bertahan pada salinitas 0.5–50 ppt, tetapi pertumbuhan optimal

umumnya dilaporkan pada kisaran 15–25 ppt. Mekanisme osmoregulasi udang memungkinkan mereka menyesuaikan tekanan osmotik tubuh dengan lingkungan, tetapi proses ini memerlukan energi ekstra. Pada salinitas di luar kisaran optimal, energi yang seharusnya dialokasikan untuk pertumbuhan teralihkan untuk mempertahankan keseimbangan ion, sehingga mengurangi laju pertumbuhan. Penelitian ini bertujuan untuk menguji pengaruh salinitas berbeda terhadap pertumbuhan dan kelangsungan hidup udang vanamei. Penelitian ini dilakukan di Laboratorium dan Workshop Budidaya Ikan PSDKU Politeknik Negeri Pontianak di Kabupaten Sukamara selama 4 bulan mulai dari persiapan hingga analisa data. Metode yang digunakan penelitian adalah rancangan acak lengkap yang terdiri dari 3 perlakuan salinitas yang berbeda dan 4 ulangan. Hasil tertinggi kinerja pertumbuhan terdapat pada P3 (salinitas 20 ppt) diikuti P2, dan P1. Sedangkan kelulusanhidup tidak menunjukkan adanya perbedaan yang signifikan, dengan kelulusan tertinggi pada perlakuan P3 sebesar 85%, serta diikuti P1, dan P2 sebesar 75%. Parameter kualitas air menunjukkan bahwa kualitas air budidaya udang masih dalam kondisi optimal yang menunjukkan bahwa suhu berkisar antara 26-28^{o}C, pH berkisar antara 7.8-8.2, dan oksigen terlarut (DO) berkisar antar 10.4-10.9 mg/L.

Kata Kunci: Udang Vanamei, Pertumbuhan, Kelangsungan Hidup, Osmoregulasi, Perbedaan Salinitas

INTRODUCTION

Sukamara Regency is a leading Regency for *Litopenaeus vannamei* shrimp aquaculture production in Central Kalimantan Province. Based on the report of the Head of UPT. BLUD PBAPL Kumai Wahyu Martha Lukyanto, today the first partial harvest in the second cycle has been carried out in the shrimp estate located in Sukamara Regency, amounting to 4.2 tons. Darliansjah revealed that this first Partial Harvest was conducted in Cluster C consisting of 12 ponds, in ponds C1–6 and C10–15 amounting to 4.2 tons. With a reduction of stocking density in Cluster C averaging 350 kg/pond. This Partial Harvest was carried out at 75 DOC shrimp age in clusters C1–6 and C10–15 with size 65–55 (MMC Kalteng, 2024).

Vannamei shrimp (*Litopenaeus vannamei*) is one of the world's main aquaculture commodities, contributing more than 70% of global shrimp production and providing the largest contribution to fishery export performance during 2015–2019 (Latifah *et al.*, 2025). The production of *vannamei* shrimp aquaculture activities has increased, especially in Asia, due to this shrimp species being categorized as an organism capable of tolerating a wide range of salinity values, relatively resistant to diseases, and having low risk of loss, thus allowing the development of environmental engineering technology for aquaculture to be applied under different salinity conditions. However, water quality is an important factor in shrimp aquaculture, including salinity, which becomes a critical factor influencing physiological performance, growth, and shrimp survival (Taqwa *et al.*, 2021). Understanding the relationship between salinity and *vannamei* shrimp productivity is essential for improving aquaculture efficiency, especially in regions with limited access to seawater or brackish water sources.

According to Sampaio *et al.* (2018), *vannamei* shrimp are classified as euryhaline organisms, meaning they are able to survive at salinity levels of 0.5–50 ppt, but optimal growth is generally reported in the range of 15–25 ppt. The osmoregulatory mechanism of shrimp enables them to adjust their internal osmotic pressure to the environment, but this process requires additional energy. At salinity levels outside the optimal range, energy that should be allocated for growth is diverted to maintaining ionic balance, thereby reducing growth rate (Taqwa *et al.*, 2021). A study by Zhang *et al.* (2014) showed that *vannamei* shrimp reared at 5 ppt experienced a 30% reduction in growth compared with the 15 ppt group. On the other hand, high salinity (>30 ppt) has been reported to increase the risk of osmotic stress and mortality in *vannamei* shrimp (Latifah *et al.*, 2025).

Several previous studies have been conducted to evaluate *vannamei* shrimp responses to salinity, with results remaining variable. For example, based on the study conducted by Taqwa *et al.* (2021), the highest growth occurred at 20–25 ppt, while the most recent research conducted by Latifah *et al.* (2025) recommended 15–20 ppt for energy efficiency. These differences are suspected to be related to variations in experimental conditions, such as water quality, feed, or shrimp strain. In addition, most studies have focused on certain growth phases, such as postlarvae or grow-out phases, hence a comprehensive analysis covering a more complete life cycle is required.

This study aims to examine the effect of different salinities on growth and survival of *vannamei* shrimp. The research results are expected to serve as a reference for farmers in adjusting salinity according to local conditions, reducing production costs (for example, by using brackish or freshwater), thereby improving sustainable *vannamei* shrimp aquaculture production.

METHODS

Time and Place

This research was carried out over a period of 4 months, beginning with the preparation phase before the study and ending with the final research activities conducted from June to September 2025. This research was conducted on a laboratory scale; observation of the research samples was carried out directly at the Fish Cultivation Workshop of PSDKU Polnep Sukamara Regency, and analysis of test results was conducted at the Fish Cultivation Laboratory of PSDKU Polnep Sukamara Regency.

Tools and Materials

The tools used in this study consisted of aquariums, fiber tanks, millimeter block paper, writing tools, aeration installation, hoses, oil pumps, filters, scoops, basins, rulers, digital scales, water quality measuring instruments (thermometer, refractometer, pH litmus paper), cameras, and filters. The materials used in this study included *vannamei* shrimp, sterilized seawater, freshwater, dolomite lime, distilled water, and shrimp feed.

Container and Media Preparation

The seawater used was obtained from shrimp cultivation ponds in coastal areas. The seawater used had undergone treatment to reduce sedimentation such as sand and silt, and to minimize pests and diseases that pose risks to cultured shrimp. Measurement of seawater salinity was carried out in the field to determine salinity levels using a refractometer, which showed that the salinity level ranged from 20 ppt.

Container preparation carried out at this stage used aquariums as test containers and fiber tanks for initial adaptation of *vannamei* shrimp. The aquariums used measured 40 × 50 × 40 cm, and the fiber tanks used had a size of 4 m² with water depth of 15 cm. The aquariums were filled with water to a height of 20 cm, but the seawater taken from the ponds was diluted beforehand by adding freshwater so that the salinity level in each aquarium corresponded to the desired value. The seawater used in this study was high-salinity seawater taken at a distance of 900 meters from the ponds to the sea.

The seawater obtained was then treated by adding chlorine, hydrogen peroxide, sodium hypochlorite, to meet water quality requirements needed for *vannamei* shrimp growth. A total of 12 aquariums were used, consisting of three treatments and four replications. Each aquarium was equipped with two aerators to maintain dissolved oxygen stability in the aquarium during the culture and research period of *vannamei* shrimp.

After seawater was transported from the ponds to the rearing tanks at the Fish Cultivation Workshop of PSDKU Politeknik Negeri Pontianak in Sukamara Regency, the salinity was diluted based on the treatments, namely salinity levels of 10, 15, and 20 ppt. The seawater dilution process was carried out using the following dilution formula:

$$C_1 x\, V_1 = C_2 x\, V_2$$

information:
C_1 = Concentration of salt solution (ppt)
C_2 = Concentration of media solution (ppt)
V_1 = Volume of salt solution (L)
V_2 = Volume of media solution (L)

Test Animals

The test animals used in this study were juvenile *vannamei* shrimp (size 55–60) obtained from BLUD Technical Implementation Unit (UPT) of Brackishwater and Marine Aquaculture Fisheries (PBAPL) Sei Raja, Sukamara Regency. Before being stocked into the aquariums, *vannamei* shrimp were acclimatized to the temperature and salinity of the rearing medium in fiber tanks containing pond water. During the rearing period, *vannamei* shrimp were fed commercial pellet feed with a feeding frequency of 3 times a day, namely in the morning, afternoon, and evening.

Stocking of Trial Shrimp and Adaptation

The *vannamei* shrimp used measured 12.2–15 cm with weights ranging from 18–19.6 grams. During stocking, *vannamei* shrimp were handled carefully using acclimatization techniques to prevent stress and mortality. Acclimatization aims to enable the organisms to withstand the salinity changes being tested. Then the *vannamei* shrimp that had been stocked into the fiber tanks for initial rearing before being transferred into the aquariums were first observed for their physiology, response, and health condition so that when the research implementation begins, other influencing factors can be minimized. After the *vannamei* shrimp during the adaptation period showed good responses and healthy and normal conditions, the first sampling was carried out to obtain data on the average length and weight of *vannamei* shrimp during the treatments. Feeding of *vannamei* shrimp in the aquariums began on the first day after the *vannamei* shrimp in the aquariums were confirmed to be in normal and healthy condition.

Shrimp Weight Sampling

The sampling procedure was carried out very carefully to minimize stress factors and mortality of the shrimp used as research test samples. The procedure for sampling the shrimp test samples followed the respective treatment containers, then continued by measuring the length per aquarium with a total of 10 samples, followed by weighing the total shrimp weight and measuring the total length of *vannamei* shrimp overall. The weight of the stocked shrimp was 18–19 grams per individual.

Measurement of Water Quality Parameters

Water quality measurements consisted of physical and chemical parameters of the waters, including temperature, pH, dissolved oxygen (DO), and salinity. Water quality measurements were conducted in the morning and afternoon to control and maintain the water quality in the research medium. If salinity levels showed changes, water addition was carried out until the rearing medium salinity corresponded to the treatment levels. To maintain good water quality

management for this study, a water change of 20% of the total volume was performed once a week.

Research Method and Design

The method used in this research was an experimental method aimed at directly analyzing how different salinity levels affect growth and survival rates of *vannamei* (*Litopenaeus vannamei*) shrimp in each of the available aquarium media.

This study was designed using a completely randomized design (CRD) with three (three) treatments and each consisting of 4 (four) replications, thus resulting in 12 (twelve) experimental units. In each experimental treatment of this study, 10 juvenile *vannamei* shrimp per aquarium were required.

The research treatments were based solely on differences in salinity levels used, and the treatments in this study consisted of:

- Treatment P1: salinity level of 10 ppt.
- Treatment P2: salinity level of 15 ppt.
- Treatment P3: salinity level of 20 ppt.

The layout of each experimental unit was arranged randomly, and the completely randomized design (CRD) of this study is presented in Figure 1.

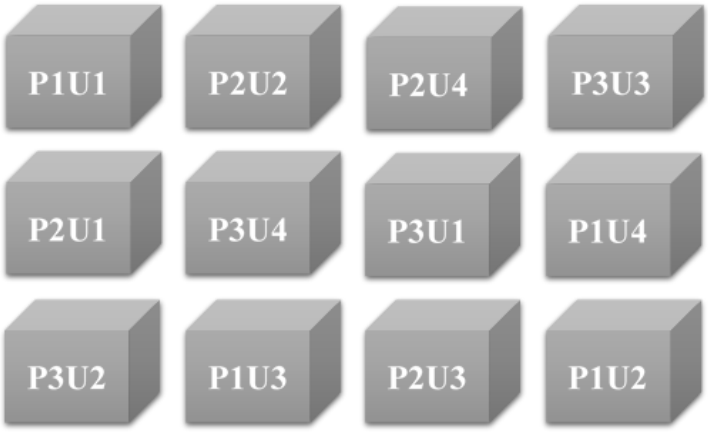

Figure 1. Layout of the Research Experimental Unit

Research Parameters

Total Shrimp Weight Growth

The total weight growth of the test animals in this study can be calculated using the formula according to Effendie (2004), namely:

$$W = w_t - w_0$$

information:

W = Absolute Weight Gain (gr)
Wt = Average final weight of the study (gr)
Wo = Average initial weight of the study (gr)

Specific Growth Rate of Shrimp

The specific growth rate (SGR) of the test animals in this study can be calculated using the formula according to Taqwa *et al*. (2021), namely:

$$SGR = \frac{lnWt - lnWo}{t} \text{ x } 100\%$$

information:
SGR = Specific growth rate (%)
Wt = Average body weight of test animals at the end of the study (g)
Wo = Average body weight of test animals at the beginning of the study (g)
t = Duration of the test animals' rearing (t)

Degree of Survival

The degree of survival or survivability of test animals, also known as the Survival Rate (SR), is obtained by calculating a formula based on calculations from Effendie, (2002).

$$SR = \frac{Nt}{N_0} \text{ x } 100\%$$

information:
SR = Survival Rate (%)
Nt = Number of shrimp at the end of the study
No = Number of shrimp at the beginning of the study

Data analysis

The data analysis method used to analyze the effect of differences in salinity on the growth and survival of whiteleg shrimp was analysis of variance, often using statistical testing tools (ANOVA) to compare the effects of salinity on test parameters between treatments. The results of the shrimp survival rate and water quality were then analyzed descriptively.

RESULTS

Total Weight of Shrimp

Total shrimp weight gain is the change in average shrimp weight from the beginning to the end of maintenance, which is calculated as the difference between the final weight and the initial weight. This value reflects shrimp growth over a certain period of time and can be influenced by various factors such as feed quality, salinity, and stocking density. Based on the results of this study, the highest total weight value was obtained in treatment P3 (20 ppt salinity) which was 7.30 grams, followed by P2 (15 ppt salinity) at 4.23 grams, and the lowest in treatment P1 (10 ppt salinity) at 2.85 grams. The results of the ANOVA test showed that differences in salinity had a significant effect ($p < 0.05$) on the absolute weight growth of whiteleg shrimp. The results of the total weight data can be seen in Figure 2.

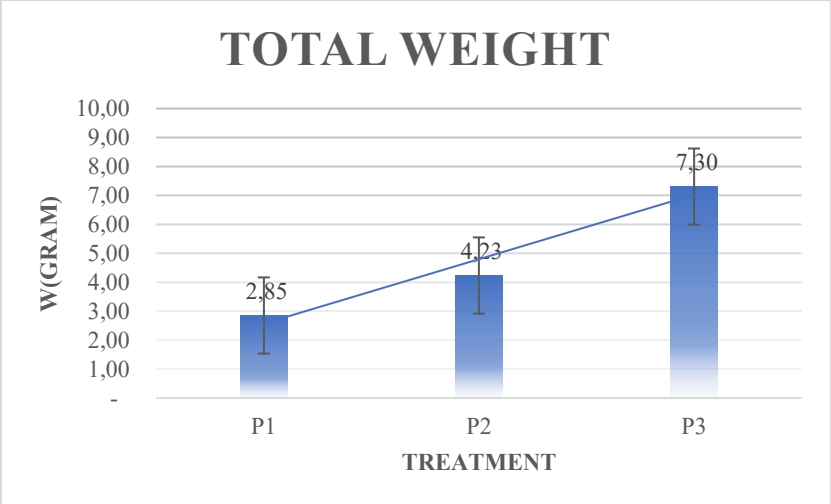

Figure 2. Graph of Total Weight of Research Animals

Specific Growth Rate of Shrimp

The Specific Growth Rate (SGR) in shrimp is the percentage of shrimp weight gain per day. It is an indicator of shrimp growth rate and is used to evaluate feed quality and the effectiveness of cultivation conditions. The results showed that the highest specific growth rate was found in treatment P3 (20 ppt salinity) at 1.18%, followed by treatment P2 (15 ppt salinity) at 0.74%, and the lowest was in treatment P1 (10 ppt salinity) at 0.55%. The ANOVA test results showed that differences in salinity significantly affected ($p < 0.05$) the specific growth rate of whiteleg shrimp. The graph of the specific growth rate of the treatments can be seen in Figure 4.

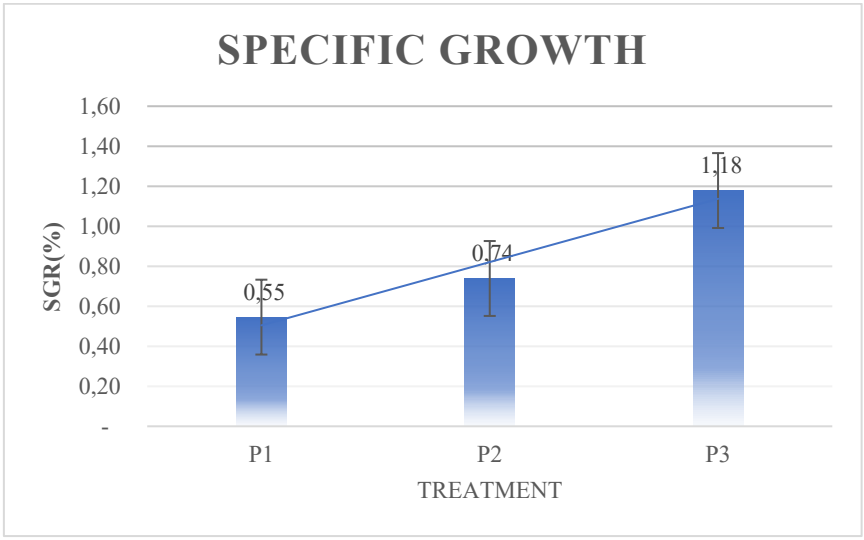

Figure 4. Graph of Specific Growth Rate of Research Test Animals

Shrimp survival

Shrimp survival is the percentage of the total number of shrimp that survive. This is an important indicator in cultivation to measure success, where a high survival rate indicates low mortality. Based on the results of the study, it shows that the highest shrimp survival rate was in treatment P3 (20 ppt salinity) at 85%, followed by P2 (15 ppt salinity) and P1 (10 ppt salinity) obtained a value of 75% each. The survival graph of the tested shrimp can be seen in Figure 5.

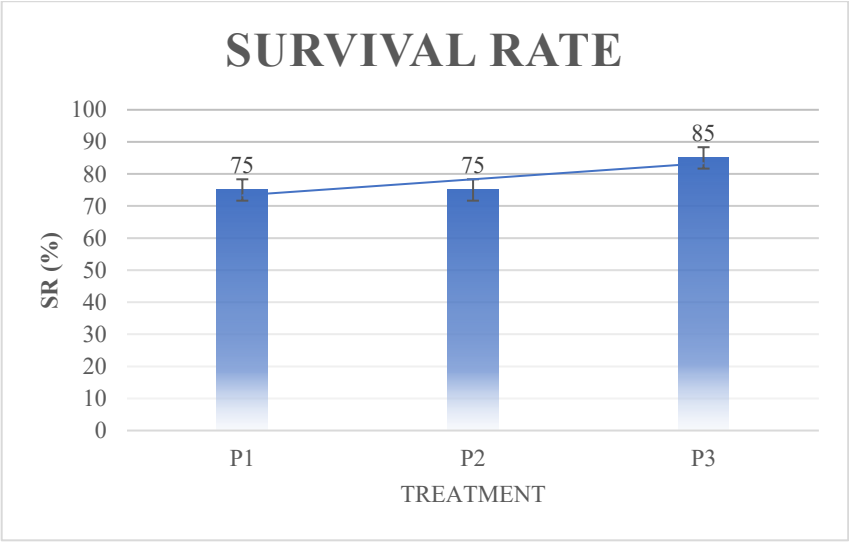

Figure 5. Survival Graph of Research Test Animals

Research Container Water Quality

Water quality parameters for research during vannamei shrimp cultivation activities need to be considered to ensure optimal water quality in each research aquarium. The results of the study indicate that the water quality in the shrimp maintenance aquariums in treatments P3 (20 ppt salinity), P2 (15 ppt salinity), and P1 (10 ppt salinity) was still considered optimal for the growth and survival of vannamei shrimp. The range of water quality data in the test shrimp maintenance aquariums is presented in Table 1.

Table 1. Water Quality Data for the Aquarium for Maintaining Research Test Animals

Parameter	Treatment			Optimum
	P1	P2	P3	
Salinity (ppt)	10	15	20	5 – 25
Temperature (°C)	26.2 – 28.4	26 – 28.1	26 – 28.3	25 – 30 °C
pH	7.8 – 8.2	7.9 – 8.1	7.9 – 8.2	6.5 – 8.5
DO (mg/L)	10.4 – 10.93	10.69 – 10.9	10.5 – 10.82	> 3

DISCUSSION

Total Shrimp Weight

The ANOVA results show that treatment P1 (salinity 10 ppt) was not significantly different from treatment P2 (salinity 15 ppt) but was significantly different from treatment P3 (salinity 20 ppt). Meanwhile, treatment P2 (salinity 15 ppt) was the same as treatment P1 but significantly different from treatment P3 (salinity 20 ppt). In treatment P3 (salinity 20 ppt), the absolute weight of vannamei shrimp was the best, which occurred due to the ability of vannamei shrimp during the water absorption process in moulting. In accordance with the research results of Se *et al*. (2022), vannamei shrimp living at a salinity of 20 ppt remain in a normal state which supports the moulting process. Moulting, known as the shedding of the shrimp's shell, is a process aimed at increasing shrimp size, characterized by an increase in body volume and body weight.

Meanwhile, for treatment P1 (salinity 10 ppt) and treatment P2 (salinity 15 ppt), negative values were obtained because the vannamei shrimp were less able to tolerate low salinity in terms of growth, resulting in suboptimal weight and non-optimal survival in these two treatments during the study. Low salinity is related to the moulting process of shrimp for growth and also affects shrimp activity, feeding habits, behavior, and reproduction, causing reduced metabolism. The shrimp will experience slow growth because the moulting process does not run optimally (Jayanti *et al*., 2022). Weight growth, whether in shrimp or other living organisms, is influenced by the nutritional sources (feed) absorbed; the better the nutritional sources absorbed by the shrimp, the faster the shrimp's weight growth (Nurhasanah *et al*., 2021). According to Wafi *et al*., (2021), maintaining good water quality in the culture medium will keep the shrimp's appetite stable. With a stable appetite, the nutrients needed by the shrimp can be fulfilled from the feed provided, resulting in increased shrimp weight.

Specific Growth Rate of Shrimp

Based on the results of this study, salinity 20 ppt (treatment P3) showed the best effect on growth performance, supported by the opinion of Rakhfid *et al*., (2019) which stated that different salinity levels for growth and survival in vannamei juvenile shrimp with treatments 20 ppt, 25 ppt, 30 ppt, and 35 ppt showed the best growth of 2.03 g/individual and the best survival of 87.50% at a salinity of 20 ppt. According to Akbar *et al*., (2023), temperature and salinity are the two most important abiotic factors that affect the growth and survival of

vannamei shrimp. When the water in the study medium has a salinity of 10 ppt, specific growth and daily growth rates were the lowest. A decrease in shrimp size indicates that the larger the shrimp, the more varied the growth rate values (Ariadi & Puspitasari, 2021). The specific growth data of vannamei shrimp in this study indicate a declining trend in growth performance as the salinity treatments decreased, supported by the study of Jayanti *et al*., (2022) which found that the highest daily growth rate of vannamei larvae maintained at different salinities was obtained in treatment C (25 ppt) and the lowest in treatment A (13 ppt), with growth differences thought to be caused by moulting differences. Optimal growth of aquatic organisms requires optimal water quality. Among the water quality parameters that play a crucial role in the growth and survival of whiteleg shrimp is salinity (Rahman *et al*., 2015).

Shrimp Survival Rate

Based on the observations of the shrimp survival rate, the results showed an average value above 75%. The high shrimp survival rate was due to the test feed consumed, which could be utilized by the shrimp for activity and survival during rearing. According to Cahyono *et al*. (2023), the survival of vannamei shrimp is not only influenced by the provision of high-quality and appropriately portioned feed but also by adequate water quality during rearing and good seed quality. Supported by Farastuti *et al*., (2023), the survival of vannamei shrimp is influenced by several factors, including water quality, the availability of feed according to shrimp needs, the ability to adapt, and stocking density. Good water quality reduces the risk of vannamei shrimp contracting diseases and increases survival rates.

This relates closely to shrimp moulting rates and cannibalism levels. A high moulting percentage results in high survival, whereas for cannibalism, the lower the cannibalism rate, the higher the survival. Shrimp cannibalism is influenced by the amount of feed available in the culture container; however, caution is needed because when shrimp become sufficiently hungry, they can become cannibalistic toward each other, even consuming adult shrimp undergoing shell change (Nurhasanah *et al*., 2021). Factors influencing survival in aquaculture are abiotic and biotic factors. Abiotic factors include physical and chemical factors of water, often referred to as water quality. Good water quality ensures physiological processes in aquatic organisms run properly, supporting growth and survival (Se *et al*., 2023).

Water Quality of Research Containers

Water quality management is a method to maintain water quality parameters according to standards suitable for cultured organisms. The water quality parameters that must be tested act as indicators to evaluate water quality, such as dissolved oxygen (DO), pH, temperature, and salinity (Suryadi *et al*., 2021). The research results indicate that water quality during shrimp rearing remained in optimal condition, with temperatures ranging from 26–28.4°C, pH ranging from 7.8–8.2, and dissolved oxygen (DO) values ranging from 10.4–10.9 mg/L. According to Al Mubarok & Farikhah (2024), suitable water quality values are an important factor in intensive shrimp farming. Besides the high stocking density, the addition of large amounts of additives can result in fluctuations in water quality, which may threaten the survival of cultured shrimp.

The water quality results obtained were relatively stable, with pH and dissolved oxygen (DO) values suitable for vannamei shrimp culture activities. Supported by the research of Putra *et al*., (2024) which stated that temperatures ranged from 27–31°C, salinity ranged from 15–23 ppt, pH reached 7, and dissolved oxygen (DO) ranged from 1.6–7.4 mg/L. This indicates that the medium used was still appropriate for culture activities. Water quality parameters are limiting factors in shrimp aquaculture (Ariadi & Mujtahidah, 2022). These findings illustrate

that the values generally still had positive effects and contributed to shrimp growth. The standard water quality criteria established by KEP.28/MEN/2004 for vannamei shrimp aquaculture are pH 6.5–8.5, dissolved oxygen (DO) > 3 mg/L, and optimum temperatures of 25–30°C.

CONCLUSION

Based on the above description, it can be concluded that there were significant effects among each treatment. The highest growth performance of vannamei shrimp was found in P3 (salinity 20 ppt), followed by P2 (salinity 15 ppt) and P1 (salinity 10 ppt). Meanwhile, vannamei shrimp survival did not show significant differences, with the highest survival in treatment P3 (salinity 20 ppt) at 85%, followed by P1 (salinity 10 ppt) and P2 (salinity 15 ppt) at 75%. Water quality parameters showed that the aquaculture water was still in optimal condition, indicating water temperatures ranging from 26–28°C, pH ranging from 7.8–8.2, and dissolved oxygen (DO) ranging from 10.4–10.9 mg/L.

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