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THE EFFECT OF DIFFERENT SALINITY ON THE SURVIVAL OF VANAME SHRIMP (*Litopenaeus vannamei*) SIZE PL8-12 IN EXPERIMENTAL TANK

Pengaruh Perbedaan Salinitas Terhadap Sintasan Udang Vaname (Litopenaeus vannamei) Ukuran PL8-12 di Bak Bak Percobaan

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ABSTRACT

Vaname shrimp (*Litopenaeus vannamei*) seed production fluctuates and naturally, seasonal factors are one of the causes. The rainy season causes sea water salinity to tend to decrease, whereas the dry season causes sea water salinity to tend to increase. Physiologically, the dynamics of salinity can influence the survival of vaname shrimp seeds and the process is regulated through osmoregulation, namely the response to regulating osmotic pressure between body fluids and the aquatic environment. This study used an experimental method with Completely Randomized Design (CRD) with 4 salinity treatments and 6 replications. The salinity tested included 27 ppt (treatment A), 29 ppt (treatment B), 31 ppt (treatment C), and 33 ppt (treatment D). The test animals for this study used whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 with an average weight of 0.001 g/individual. The stocking density was 15 individuals/liter and the maintenance media was a mixture of seawater and freshwater with a total volume of 3 liters/tank. The results showed that treatment D produced the best effect for the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 of 98.5%. Water quality data obtained from acidity levels of 8.3-8.5, temperatures ranging from 27-28^{0}C and dissolved oxygen ranging from 4.4-4.5 ppm.

Key words: Salinity Differences, Survival, Post Larvae Vaname Shrimp

ABSTRAK

Produksi benih udang vaname (*Litopenaeus vannamei*) berfluktuasi dan secara alami, faktor musiman menjadi salah satu penyebabnya. Musim hujan menyebabkan salinitas air laut cenderung menurun, sedangkan musim kemarau menyebabkan salinitas air laut cenderung meningkat. Secara fisiologis, dinamika salinitas dapat mempengaruhi kelangsungan hidup bibit udang vaname dan prosesnya diatur melalui osmoregulasi, yaitu respon terhadap pengaturan tekanan osmotik antara cairan tubuh dan lingkungan perairan. Penelitian ini menggunakan metode eksperimental dengan *Completely Randomized Design* (CRD) dengan 4 perlakuan salinitas dan 6 kali ulangan. Salinitas yang diuji meliputi 27 ppt (perlakuan A), 29 ppt (perlakuan B), 31 ppt (perlakuan C), dan 33 ppt (perlakuan D). Satwa uji penelitian ini menggunakan udang vaname (*Litopenaeus vannamei*) ukuran PL8-12 dengan berat rata-rata 0,001 g/individu. Kepadatan tebar 15 individu per liter dan media pemeliharaan berupa campuran air laut dan air tawar dengan volume total 3 liter per bak.. Hasil menunjukkan bahwa perlakuan D menghasilkan efek terbaik untuk kelangsungan hidup udang vaname (*Litopenaeus* *vannamei*) ukuran PL8-12 sebesar 98,5%. Data kualitas air diperoleh dari tingkat keasaman 8,3-8,5, suhu berkisar antara 27-280C, dan oksigen terlarut antara 4,4-4,5 ppm.

Kata Kunci: Perbedaan Salinitas, Kelangsungan Hidup, Udang Vaname Pasca Larva

INTRODUCTION

Whiteleg shrimp (*Litopenaeus vannamei*) is one of the rapidly growing fishery commodities in Indonesia. Whiteleg shrimp originates from the western Pacific coast of Latin America, from Peru to Mexico. Whiteleg shrimp began to be introduced in Indonesia and officially released in 2001 (Nababan *et al.,* 2015). One of the most profitable fishery commodities is whiteleg shrimp (Herawati & Hutabarata. 2014). This is because whiteleg shrimp are more resistant to disease, grow faster, are resistant to environmental changes, are feed efficient, and have a high survival rate (Anita *et al.,* 2017).

According to data from the Ministry of Maritime Affairs and Fisheries (2020), vaname shrimp production reached 717,094 tons in 2018 and increased by 46.4% to 1.05 million tons in 2019. These shrimp are known as euryhaline organisms because of their ability to adapt to salinities between 5 and 30 ppt (Jayanti *et al.,* 2022).

Jayanti *et al.,* (2022), stated that whiteleg shrimp cultivation is usually carried out in environments with high salinity levels, such as ponds or coastal areas. The salinity level affects the survival and viability of whiteleg shrimp through the mechanism of the osmoregulation process, namely the efforts of aquatic organisms to control the balance between fluid concentration and osmotic pressure between the body and its environment (Karim & Trijuno, 2016). According to Primiati and Dewi (2019), the higher the salinity of the maintenance medium, the greater the difference in solution pressure in the body and its environment will tend to increase, as a result of which salts enter the tissue through the semipermeable body surface until there is a balance between the osmotic pressure in the shrimp's body and its environment. Conversely, the lower the salinity of the maintenance medium, the greater the difference in solution pressure in the body and its environment will tend to decrease, as a result of which salts will exit through the semipermeable body surface tissue until there is a balance between the osmotic pressure in the shrimp's body and its environment, so that body fluids become more dilute. These possibilities can have a negative effect on the survival of whiteleg shrimp post larvae.

The production of whiteleg shrimp seeds often decreases during the rainy season and long dry season. The rainy season causes the salinity of seawater to tend to decrease and in the dry season the salinity of seawater tends to increase due to the evaporation process. The survival process of whiteleg shrimp after larvae can be affected by salinity fluctuations. Osmotic pressure increases with salinity, and vice versa (Yulistyaningsih *et al.,* 2020). Water salinity that is too high will cause shrimp to become stressed and their growth will decrease. Conversely, water salinity that is too low will cause shrimp to be unable to absorb enough oxygen, which causes respiratory problems (Fortuna, 2024).

Jayanti (2022), argues that one of the important factors in the whiteleg shrimp seeding effort is to increase its survival by maintaining salinity stability in the maintenance medium. As is well known, the size of whiteleg shrimp seeds measuring PL8-12 is very vulnerable to changes in water salinity (Witoko *et al.,* 2018). Reported by (Krisandin, 2023), that the death rate of vaname shrimp fry during the rainy season is around 40%, while during the dry season it is around 20 - 30%.

Based on the description above, research on how different salinity levels affect the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 should be conducted in experimental tanks.

RESEARCH METHODS

This research was conducted in Bulu Village, Jepara District, Jepara Regency, Central Java Province, for seven days, from June 1 to June 7, 2024. The tools used in this study include an aerator and its equipment, a tub to store 24 5-liter jars, DO meter, PH meter, thermometer, refractometer, knife, vaname shrimp scoop, digital scale, 1-liter measuring cup, and siphon hose. PL8-12 vaname shrimp, commercial hida feed, seawater (35 ppt), fresh water (0 ppt), and detergent or disinfectant.

The research container used 24 plastic tubs with a capacity of 5 liters. With a volume of 3 liters, the plastic tub is filled with water produced from diluting a mixture of seawater and fresh water with a salinity level adjusted to the treatment. Water must be settled for 24 hours before use to ensure that there are no substances that can cause disease. The formula guideline made by Hariyadi (2003) was used to dilute the mixture of seawater with fresh water; here, N1 is the salinity of seawater (35 ppt), V1 is the volume of seawater (liters), N2 is the salinity of the treatment (ppt), and V2 is the volume of research media water (3 liters).

Whiteleg shrimp size PL8-12 with an average weight of 0.001 grams per head were used as experimental animals. Whiteleg shrimp larvae were obtained from the Hatchery. The animals used in this study have complete organs and are free from all diseases. These animals tend to have a uniform size, agile movements, and complete organs (no defects). Because each research tank has a volume of 3 liters, 24 tanks, and 15 stocking density per liter, the number of test animals needed for the study was 1080.

This study uses an experimental method, which aims to test the effect of one variable on another variable. This method is the most reliable (most valid) because it is carried out with strict control of other confounding variables (Jaedun, 2016). The experimental method used in this study was a Completely Randomized Design (CRD), which used four treatments and six replications, according to the formula proposed by Kusriningrum (2010).

RESULT

Survival Rate of Whiteleg Shrimp (*Litopenaeus vannamei*)

Based on the results of research on how differences in salinity affect the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in experimental tanks. The range, average and standard deviation of the survival of whiteleg shrimp *(Litopenaeus vannamei)* size PL8-12 for each treatment.

Tabel 1. Menunjukkan kisaran, rata-rata dan standar deviasi sintasan udang vaname (*Litopenaeus vannamei)* ukuran PL8-12

Treatment	Survival Rate of Whiteleg Shrimp (*Litopenaeus vannamei*)	Average	Standard deviation (sd)
A	91,1-93,1	91,8	1,1
B	93,3-95,6	94,1	1,2
C	95,6-97,8	96,3	1,1
D	95,6-100	98,5	2,3

Based on Table 1 above, it can be concluded that treatment D showed the highest average value in terms of survival of whiteleg shrimp (*Litopenaeus vannamei*) with size PL8-12. The survival graph of whiteleg shrimp (*Litopenaeus vannamei*) with size PL8-12 is shown in Figure 1 below.

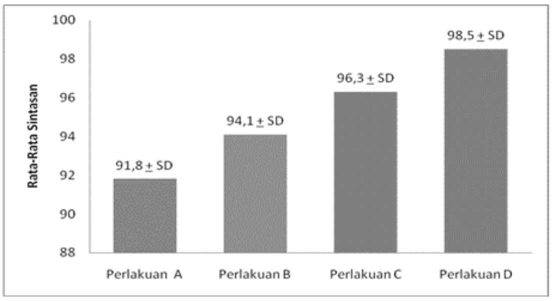

Figure 1. Survival graph of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12

Furthermore, the average of treatments C, B, and A showed a sequential decrease. To determine whether there was a significant difference between treatments, a one-way ANOVA test was conducted. The results of the test are presented in Table 2 below.

Table 2. Results of the one-way ANOVA test

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	150,085	3	50,028	21,859	0,000
Within Groups	45,773	20	2,289		
Total	195,858	23			

Based on Table 2, it can be concluded that salinity variation has a significant effect on the survival rate of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 (P<0.05). To determine the level of difference between treatments on the survival rate of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12, an LSD test was conducted at the 5% level. The results of the 5% LSD test calculation and the average survival notation are presented in Appendix 11, while Table 3 below summarizes the notation of the results.

Table 3. Notation of the results of the LSD test at 5% level for the average survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12.

Treatment	N	Subset for alpha = 0,05			
		1	2	3	4
A	6	91,8[a]			
B	6		94,1[b]		
C	6			96,3[c]	
D	6				98,5[d]

Based on Table 3, it can be explained that treatment A is significantly different from treatments B, C, and D. Treatment B also shows significant differences compared to treatments C and D. In addition, treatment C is significantly different from treatment D.

Water Quality

pH (acidity levels)

The results of the study showed that the range of acidity levels was in the range of 8.3–8.5. The range, average, and standard deviation of acidity levels for each treatment are presented in Table 4 below.

Table 4. Range, average, and standard deviation of acidity levels for each treatment

Treatment	Range	Average	Standard Deviation (sd)
A	8,3-85	8,4	0,1
B	8,3-8,5	8,4	0,1
C	8,3-8,5	8,4	0,1
D	8,3-8,5	8,4	0,1

Based on Table 4, it can be explained that the average acidity level in each treatment statistically shows relatively similar values. To determine whether there is a significant difference between treatments in acidity levels, a one-way ANOVA test was conducted. The results of the test can be seen in Table 5 below.

Table 5. One-way ANOVA test of acidity levels

	Sum of Squares	Df	Mean Square	F	Sig
Between Groups	0,001	3	0,000	0,1	0,9
Within Groups	0,149	20	0,007		
Total	0,150	23			

Based on Table 5, it can be concluded that the acidity level in each treatment did not have a significant effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 (P > 0.05).

Temperature

The results of the study showed that the temperature range was in the range of 27–28°C. The range, average, and standard deviation of temperature for each treatment are presented in Table 6 below.

Table 6. Range, average, and standard deviation of temperature levels for each treatment

Treatment	Range	Average	Standard Deviation (sd)
A	27-28	27,7	0,5
B	27-28	27,5	0,5
C	27-28	27,8	0,4
D	27-28	27,5	0,5

Based on Table 6, the average temperature in each treatment statistically shows relatively similar values. To determine whether there is a significant difference between treatments in temperature levels, a one-way ANOVA test was conducted, as shown in Table 7 below.

Table 7. One-way ANOVA test of temperature levels

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0,458	3	0,153	0,591	0,628
Within Groups	5,167	20	0,258		
Total	5,625	20			

Based on Table 7, it can be concluded that the temperature levels in each treatment did not have a significant effect on the survival of whiteleg shrimp (Litopenaeus vannamei) size PL8-12 (P > 0.05).

Dissolved Oxygen (DO)

The results showed that the dissolved oxygen levels were in the range of 4.4–4.5 ppm. The range, average, and standard deviation of dissolved oxygen levels for each treatment are presented in Table 8 below.

Table 8. Range, average, and standard deviation of dissolved oxygen levels for each treatment

Treatment	Range	Average	Standard Deviation (sd)
A	4,4-4,5	4,5	0,04
B	4,4-4,5	4,5	0,05
C	4,4-4,5	4,5	0,05
D	4,4-4,5	4,5	0,05

Based on Table 8, it can be explained that statistically the average dissolved oxygen levels in each treatment showed relatively similar values. To determine whether there were significant differences between treatments in dissolved oxygen levels, a one-way ANOVA test was conducted. The results of the test are presented in Table 9 below.

Table 9. One-way ANOVA test of temperature levels

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0,001	3	0,000	0,2	0,9
Within Groups	0,049	20	0,002		
Total	0,50	23			

Based on Table 9, it can be concluded that the dissolved oxygen levels in each treatment did not have a significant effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 (P > 0.05).

DISCUSSION

Survival Rate of Vaname Shrimp (Litopenaeus vannamei) Size PL8-12

Based on the results of the study on how the effect of salinity differences on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in experimental tanks, the average survival rate showed that treatment A reached 91.8%, treatment B was 94.1%, treatment C was 96.3%, and treatment D reached 98.5%. Furthermore, the results of the one-way ANOVA test showed that differences in salinity had a significantly different effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in experimental tanks.

Treatment D had the highest effect on the survival rate of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in experimental tanks. The salinity level of treatment D had the closest distance to the initial medium salinity of 35 ppt so that the osmoregulation process in treatment E ran most normally. The osmotic pressure of the cytoplasmic cell fluid with the osmotic pressure of the research medium was balanced and the research medium in treatment D looked clear/not cloudy or known as isotonic. The isotonic condition causes physiological processes in cells to run optimally so that whiteleg shrimp fry have the highest survival rate (Irianingrum *et al.*, 2023). Anita *et al.*, (2017), stated that salinity is known to play an important role in aquatic organisms to maintain the balance of water and ions between the body and its environment. Stable media salinity can accelerate growth and reduce the risk of death. The optimal salinity level requirement for post-larvae survival of whiteleg shrimp is between 33 - 35 ppt (Anisa *et al.*, 2021). Meanwhile, Ani *et al.*, (2017), argues that salinity levels ranging from 32-34 ppt can maintain the survival rate of post-larvae of whiteleg shrimp around 98-100%.

Treatment A had the lowest effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in the experimental tanks. The salinity level of treatment A had the furthest distance from the initial medium salinity of 35 ppt so that it could push the concentration of cytoplasmic cell fluid to the greatest extent out into the research medium and appear the most turbid when compared to other treatments. In these conditions, the cytoplasmic cell fluid is hypertonic (higher osmotic pressure) and the research medium is hypotonic (lower osmotic pressure), as a result, the adaptation process through the osmoregulation process between the concentration of cytoplasmic cell fluid and its environment experiences the highest level of difficulty, it is natural that in treatment A the number of whiteleg shrimp fry died the most. When salinity conditions fluctuate, whiteleg shrimp fry require more energy for the metabolic process, which can affect their survival rate (Amiruddin, 2016). According to (Utami, 2023), if the concentration of salt levels in the cytoplasmic cells is hypertonic and the maintenance medium is hypotonic, then the structure shrinks or is known as crenation, even in extreme conditions the cells are shaped like ghost cells.

Treatments C and B sequentially had a decreasing effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in the experimental tanks. Both treatments had salinity levels that were increasingly far from the initial medium salinity of 33 ppt. The osmoregulation process was almost the same as treatment A and began to look disturbed because the cytoplasmic cell fluid was increasingly released into the maintenance medium and looked increasingly cloudy. As a result, the number of dead whiteleg shrimp fry increased, but the number was not as much as treatment A. Differences in salinity levels can affect the growth rate and survival rate of whiteleg shrimp fry.

Water Quality

During the study, the water quality of the experimental media was relatively homogeneous and within the normal range that could be tolerated by koi fish seeds to support the level of brightness of their color.

Acidity Degree (pH)

The acidity degree of the water in the research media is in the range of 8.3–8.5, which is still within normal limits. According to Bayu and Sugito (2017), the optimal pH for the survival of vannamei shrimp larvae is between 6.5–8.5.

Temperature

The water temperature of the research media ranges from 27–28°C, which is within the normal range (Fikriyah *et al.*, 2023), stating that the safe water temperature for maintaining vannamei shrimp post-larvae is in the range of 27–30°C.

Dissolved Oxygen (DO)

The dissolved oxygen levels in the research media range from 4.4–4.5 ppm, which is also within normal limits. (Hakim, 2023), the safe limit for dissolved oxygen levels for maintaining vannamei shrimp post-larvae is around 4–5.9 ppm. Vanamei shrimp fry can grow well with oxygen levels between 4 – 6 ppm (Anisa *et al.*, 2021).

CONCLUSION

Based on the results of the study on how the difference in salinity affects the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12 in experimental tanks, it was concluded that the difference in salinity had a significant effect on the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12, with treatment D giving the highest result of 98.5%. Water quality data showed that the acidity level ranged from 8.3-8.5, the temperature ranged from 27-28°C, and the dissolved oxygen level ranged from 4.4-4.5 ppm. The three levels of water quality were homogeneous, meaning that they did not significantly affect the survival of whiteleg shrimp (*Litopenaeus vannamei*) size PL8-12.

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