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GROWTH PERFORMANCE OF WHITELEG SHRIMP (*Litopenaeus vannamei*) AT DOC 90 IN DIFFERENT POND SHAPES UNDER INTENSIVE AQUACULTURE SYSTEM

Studi Pembesaran Udang Vannamei (*Litopenaeus vannamei*) Doc 90 pada Bentuk Kolam yang Berbeda dengan Sistem Budidaya Intensif

Mukhammad Lukman Hakim[1], Sri Oetami Madyowati, A. Kusyairi

Department of Aquaculture, Faculty of Agriculture, Dr. Soetomo University

Semolowaru Street No. 84, Menur Pumpungan, Sukolilo District, Surabaya City, East Java 60118

*Corresponding Author: lukmanagassi84@gmail.com

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ABSTRACT

This study aims to evaluate the effect of pond shape on the production performance of Litopenaeus vannamei in an intensive aquaculture system. Six ponds were used as experimental units, consisting of three square ponds (C1, C2, C3) and three circular ponds (C4, C5, C6), each stocked with 92,400 shrimp at an initial mean body weight (MBW) of 0.018 grams. Key parameters observed included initial biomass, final production, and average harvest yield. Results showed that circular ponds yielded higher production, with an average of 894 kg, compared to square ponds with an average of 758 kg. The Shapiro-Wilk normality test confirmed data normality, while the paired sample t-test indicated a statistically significant difference between the two pond shapes (p = 0.000). The superior performance of circular ponds is attributed to more uniform water circulation, efficient feed distribution, and optimized waste management. These findings highlight the importance of pond design in enhancing the productivity of L. vannamei under intensive farming conditions.

Keywords: Litopenaeus vannamei, pond shape, shrimp production, circular pond, intensive aquaculture

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pengaruh bentuk kolam terhadap hasil produksi udang vannamei (*Litopenaeus vannamei*) dalam sistem budidaya intensif. Enam kolam digunakan sebagai unit eksperimen, terdiri atas tiga kolam berbentuk persegi (C1, C2, C3) dan tiga kolam berbentuk bundar (C4, C5, C6), masing-masing dengan jumlah tebar 92.400 ekor dan MBW awal 0,018 gram. Parameter utama yang diamati meliputi biomassa awal, produksi akhir, dan rata-rata hasil panen. Hasil menunjukkan bahwa kolam berbentuk bundar menghasilkan produksi lebih tinggi dengan rata-rata 894 kg dibandingkan kolam persegi dengan rata-rata 758 kg. Uji normalitas menggunakan Shapiro-Wilk menunjukkan data berdistribusi normal, sedangkan uji *paired sample t-test* mengindikasikan perbedaan signifikan antar bentuk kolam (p = 0,000). Keunggulan kolam bundar dikaitkan dengan sirkulasi air yang lebih merata, distribusi pakan yang efisien, dan pengelolaan limbah yang optimal. Temuan ini menegaskan bahwa desain kolam merupakan faktor krusial dalam peningkatan produktivitas udang vannamei.

Kata kunci: *Litopenaeus vannamei*, bentuk kolam, produksi udang, kolam bundar, budidaya intensif

INTRODUCTION

Whiteleg shrimp (Litopenaeus vannamei) is a key commodity in Indonesia's aquaculture sector, playing a crucial role in supporting national economic growth, particularly through its contribution to foreign exchange exports. Demand for these shrimp, both domestically and internationally, continues to show an upward trend due to a number of advantages, such as rapid growth, good adaptation to various environmental conditions, and efficient feed utilization (Usman et al., 2022). The relatively stable selling price also makes whiteleg shrimp a primary choice among farmers. According to data from the Ministry of Maritime Affairs and Fisheries (KKP), whiteleg shrimp production increased from 953,177 tons in 2021 to 1,130,000 tons in 2024. However, this achievement still falls short of the national target of 2 million tons per year, necessitating ongoing efforts to optimize the cultivation system. One approach is to implement innovations in pond design and more efficient cultivation technology (Farkan et al., 2024).

However, increased national production is not always accompanied by increased business efficiency among small and medium-sized farmers. The main challenge often faced is high operational costs, particularly in water quality management and feed efficiency. Suwoyo & Tahe (2011) emphasize the importance of managing technical aspects such as the feed conversion ratio (FCR) in increasing productivity. Furthermore, other serious threats come from diseases such as White Spot Syndrome Virus (WSSV) and Acute Hepatopancreatic Necrosis Disease (AHPND), which can cause mass shrimp mortality. This condition is often exacerbated by declining water quality, particularly due to the accumulation of toxic substances such as ammonia and nitrite, which trigger physiological stress and weaken the shrimp's immune system (Ade, 2023).

In intensive farming systems, environmental conditions—particularly water quality—play a crucial role in determining production success. Physical and chemical water parameters such as pH, salinity, temperature, and dissolved oxygen (DO) levels must remain within optimal limits to support the growth and survival of whiteleg shrimp. Jelinda et al. (2024) stated that the ideal pH range is 7.8–8.5, optimal salinity is 15–30 ppt, water temperature is 25–30°C, and DO is at least ≥3.5 ppm. Deviations from these values can disrupt shrimp metabolism, reduce appetite, and trigger physiological stress (Farabi, 2023).

One technical aspect that is rarely addressed in depth from a farmer's perspective is pond shape. Pond shape plays a crucial role in influencing microenvironmental conditions within the pond, such as water circulation, feed distribution, and organic waste accumulation. Circular ponds are known to have the advantage of evenly distributing water flow and oxygen, where a lower FCR value indicates more efficient feed provision in supporting shrimp growth. Meanwhile, rectangular ponds are also widely used because they support oxygen distribution, although organic waste management tends to be more difficult than circular ponds (Fidari et al., 2017).

In addition to pond shape, the pond base material also determines the quality of cultivation. Tarpaulin ponds, for example, offer advantages in terms of cleanliness and temperature control due to their easy-to-clean material and their low heat absorption capacity. These variations in pond shape and material create different environmental conditions, which ultimately affect shrimp growth performance and survival (Aminin et al., 2023).

Fatimah et al. (2022) added that pond shape significantly influences feed distribution. In circular ponds, feed is more evenly distributed and competition between individuals is reduced, thus positively impacting feed efficiency. Therefore, selecting the right pond shape can be key to increasing the productivity of whiteleg shrimp cultivation sustainably.

Based on this description, it is important to understand how farmer perceptions of pond shape influence cultivation success, especially in the context of small and medium-sized farmers. This study aims to examine the relationship between pond shape and production and success of whiteleg shrimp cultivation from the farmer's perspective, with the hope of providing practical input for the development of more adaptive and efficient pond designs.

RESEARCH METHODS

Place and Time

This research was conducted from October to December 2024 at an intensive cultivation site owned by UD. Hidayah Vaname, located in Pesisir Village, Dringu District, Probolinggo Regency, East Java. This location was chosen due to the consistent implementation of the intensive cultivation system and the availability of ponds with different shapes within a single management unit. Shrimp cultivation activities lasted for 90 days, starting from post-larvae (PL12) to harvest at DOC 90, from May to August 2023.

Tools and Materials

This research used various tools and supporting materials. The tools used included a DO meter and pH meter for water quality measurements, a precision digital scale for biomass weighing, and other supporting equipment such as scoops, sampling nets, plastic basins, and stationery. The materials used in the research included vannamei shrimp, pellet feed, probiotics (Lactobacillus sp.), seawater and soil, H_2O_2, chlorine, micro minerals, and lime. Seawater with a salinity of 28–32 ppt was used as the maintenance medium.

Test Animals

The test animals used were PL12 stage whiteleg shrimp (Litopenaeus vannamei) fry obtained from a certified hatchery. The fry had an initial mean body weight (MBW) of 0.018 grams and were declared healthy based on morphological observations.

Research Container

A total of six ponds were used as experimental units, consisting of three tarpaulin-lined circular ponds (C4, C5, C6) and three concrete rectangular ponds (C1, C2, C3). All ponds had an effective volume of approximately 40 m^3, with a stocking density of 92,400 individuals per pond. The selection of the number and type of ponds followed standard intensive farming practices commonly applied in the field (Irsyam et al., 2019; Supriatna et al., 2020).

Research methods

This study used a quantitative approach with a comparative descriptive method. The goal was to compare vannamei shrimp production results based on pond shape (round and square) in an intensive cultivation system. The independent variable in this study was pond shape (circular vs. square), while the dependent variable was shrimp production, measured by total biomass (kg) at the end of the culture. Control variables included the management system, stocking density, feed type, and water quality management, which were standardized across all ponds.

Research Procedures

The research procedure was divided into two main stages: preparation and implementation. The preparation phase included the preparation of the pond, water, probiotics, and test animals. The pond was thoroughly cleaned, dried, and then sterilized with chlorine and H_2O_2 to suppress pathogenic microorganisms. Cultivation water was obtained by mixing seawater and groundwater in a 1:1 ratio, then neutralized with lime to reach the optimal salinity (15–25 ppt). Probiotics (Lactobacillus sp.) were cultured for 48 hours with molasses and yeast as a growth medium, then applied to the pond as part of biosecurity and to control pathogenic bacteria. SPF-certified PL12 vannamei shrimp fry were acclimatized before being released into the pond to allow them to adjust to the environmental conditions.

The implementation phase began with the early morning release of the fry to avoid temperature stress. Daily maintenance was carried out intensively for 90 days, which included feeding four times a day, siphoning and changing water twice a day, and measuring water quality parameters such as temperature, pH, salinity, and dissolved oxygen. Feeding followed the blind feeding method until DOC 30 and was then adjusted based on biomass and ADG (Average Daily Growth) data from sampling results. Probiotics and minerals were added periodically to support shrimp health and growth. Anco system was used to monitor feed consumption and shrimp behavior. Harvesting was carried out twice: a partial harvest at DOC 50 to reduce density and a total harvest at DOC 90 to end the cultivation cycle.

Data Analysis

The data analysis in this study aimed to evaluate whether there were significant differences between vannamei shrimp production in circular and rectangular ponds. Prior to conducting the main statistical tests, the data were first tested for normality using the Shapiro-Wilk test. This test was chosen because it is more accurate for small sample sizes and aims to determine whether the data are normally distributed. The criterion for normality is determined by a significance value (p) > 0.05 (Purba et al., 2021). If the data are found to be normal, the parametric testing phase can proceed.

For water quality data, a homogeneity test was performed using Levene's test using SPSS version 20 software. Homogeneity is required in analysis of variance (ANOVA) to ensure unbiased conclusions. Data are considered homogeneous if the significance value is > 0.05 (Hidayat, 2021). If the requirements for normality and homogeneity are met, the ANOVA test can be used to determine whether differences between groups (circular and rectangular ponds) in water quality parameters are significant.

Meanwhile, for the main research variable, namely vannamei shrimp production yield, a paired sample t-test was used to analyze differences between treatment groups. This test was conducted because the data were in pairs that were interrelated (e.g., initial weight and harvest yield from the same pond) (Syafriani et al. 2023). The test was conducted at a significance level of 5% ($\alpha = 0.05$). The null hypothesis (H_0) states that there is no significant effect of pond shape on production yield, while the alternative hypothesis (H_1) states that there is a significant effect. If the Sig. value (2-tailed) <0.05, then H_0 is rejected and H_1 is accepted, which means that pond shape has a significant effect on vannamei shrimp harvest yield.

RESULT

Vannamei Shrimp Production Results

This study yielded data on vannamei shrimp production from two different pond types: rectangular ponds (C1, C2, C3) and circular ponds (C4, C5, C6), with a 90-day maintenance period. The following summarizes the harvest data from each pond:

Table 1: Data on initial stocking volume, initial stocking MBW, initial stocking biomass, final production, and average production, after different pond shapes.

Pool Number	Pool Number)	MBW Initial Spread (Gram)	Initial Stocking Biomass (Kg)	Final Production (Kg)	Average Final Production (Kg)
SQUARE POOL (C1, C2, C3)					
C1	92.400	0,018	1,6632	750	758
C2	92.400	0,018	1,6632	743	
C3	92.400	0,018	1,6632	783	
ROUND POOL (C4, C5, C6)					
C4	92.400	0,018	1,6632	916	894
C5	92.400	0,018	1,6632	892	
C6	92.400	0,018	1,6632	874	

Based on Table 1, to evaluate whether the production data, both initial weight (pre-test) and final production (post-test), followed a normal distribution, a normality test was performed. This test used the Shapiro-Wilk method, which is appropriate for relatively small sample sizes. The results of the normality test for initial weight and final production data after treatment with various pond shapes are shown in Table 4.2.

Table 2: Normality Test for Initial Weight (Pre-test) and Partial Production (Post-test)

Variables	**Kolmogorov-Smirnov**			**Shapiro-Wilk**		
	Statistics	**df**	**Sig.**	**Statistics**	**df**	**Sig.**
Pre-test		6			6	
Post-test	0.233	6	0.200*	0.865	6	0.207

Description: Significance level α = 0.05

Referring to Table 2, the significance value for the pre-test (initial weight) was recorded at 0.000, while for the post-test (final production weight) it was 0.207. Because the post-test significance value exceeded the 0.05 threshold, it can be concluded that both data sets—initial weight and final production—had a normal distribution, both in rectangular and circular ponds.

Next, to determine whether there was a significant difference between the two paired data sets, analysis was conducted using a paired sample t-test. This test is used to compare the means of two related data sets: initial weight (pre-test) and final harvest weight (post-test). The results of the paired sample t-test are presented in Table 3 below.

Table 4.3. Paired sample t-test results for the difference in initial weight and final production in rectangular and circular ponds are presented in the table below.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pre_test - post_test	-.825333	.076516	.031237	-.905632	-.745035	-26.421	5	.000

The results in Table 3 show that the significance value (p-value) in the Sig. (2-tailed) test is 0.000. Because this value is below the threshold of 0.05, H_0 is rejected and H_1 is accepted. Thus, it can be concluded that differences in pond shape in intensive cultivation systems up to DOC 90 have a significant effect on vannamei shrimp production results.

DISCUSSION

The research results showed a significant increase in whiteleg shrimp (Litopenaeus vannamei) production during the rearing period until harvest, from PL12 to DOC 90. These results indicate that the applied cultivation system, including stocking density, water management, feeding, and the use of probiotics and minerals, significantly increased shrimp biomass during the rearing phase.

Final production results showed quite striking variations between rectangular and circular ponds. The rectangular pond (C1) achieved a final production yield of 750 kg, the circular pond (C2) achieved a final production yield of 743 kg, and the circular pond (C3) achieved a final production yield of 783 kg. The total average final production yield for the rectangular pond was 758 kg. Meanwhile, the circular pond (C4) achieved a total final production yield of 916 kg, pond (C5) achieved a total final production yield of 892 kg, and pond (C6) achieved a total final production yield of 874 kg. The average final production yield for the circular ponds was 894 kg.

The results showed that circular ponds produced higher vannamei shrimp production than rectangular ponds. This difference is closely related to the pond's structural design, which directly impacts water circulation, feed distribution, and efficient waste management. The circular pond shape has the advantage of creating a uniform water flow throughout the pond. The absence of dead corners in circular ponds allows for more homogeneous feed distribution, ensuring optimal utilization by the entire shrimp population. Furthermore, this design also siphons off organic waste, such as leftover feed and feces, which naturally collect in the central drain. The routine daily siphoning process helps maintain stable aquaculture environment quality and minimizes the accumulation of pollutants. Fatimah et al., (2022) supported these findings by stating that good water circulation is a crucial factor in maintaining the quality of aquaculture water, as it reduces the risk of quality degradation due to the accumulation of organic waste. Thus, circular ponds structurally support an effective and efficient circulation system. Furthermore, Sahabudin et al., (2020) demonstrated that the use of circular ponds combined with a biofloc system can increase shrimp production by 10–15%. This demonstrates that pond design that supports dynamic water flow and efficient waste management can create an ideal environment for shrimp growth and health.

In contrast, rectangular ponds tend to have uneven feed distribution due to dead corners that impede water circulation, making cleaning up leftover feed and feces more difficult. According to Husna et al. (2023), if not properly designed, rectangular ponds can have poor water quality due to waste accumulation in the corners. However, in terms of individual growth, rectangular ponds show better results than circular ponds. This is likely due to the larger space for movement and more optimal oxygen distribution, both of which contribute to increased shrimp growth during the rearing period.

The striking difference in production between rectangular and circular ponds is thought to be caused by a number of factors, both biological and non-biological. In the mid-stage of the rearing period, some ponds experienced health problems characterized by the emergence of White Feces Disease (WFD) infections. Visually, this infection can be identified through symptoms such as decreased appetite, the appearance of white feces floating on the water surface, a change in intestinal color to white, and suboptimal shrimp growth (Farastuti, 2023). This event negatively impacts pond production by causing a decrease in biomass and even increasing mass mortality in whiteleg shrimp (Kaemudin et al., 2016).

One biological explanation underlying this disparity in production results is the mass molting phase, which occurs before harvest time. Molting is a crucial physiological process in the shrimp life cycle, where the old exoskeleton is shed and replaced by a new, soft exoskeleton. During this phase, shrimp experience a temporary decrease in body weight due to the loss of hard tissue and the failure to fully accumulate new biomass (Jayanti et al., 2022). Research by Nurhasanah et al. (2021) indicates that a high molting frequency is closely correlated with increased growth, but also causes fluctuations in daily weight values depending on the time of day. The active molting phase can lead to a decrease in daily growth rate when it occurs massively, although in the long term it contributes positively to total biomass (Taqwa et al., 2014).

Based on these considerations, low production in some ponds can be attributed to the ongoing molting process and White Feces Disease (WFD) infection. These conditions are important factors in determining the appropriate harvest time to ensure optimal shrimp weight. Furthermore, consistent cultivation management practices across both pond types contribute to increased production. Uniformity in feed use, aeration systems, and probiotic and mineral applications significantly contribute to maintaining stable production performance.

CONCLUSION

Based on the results of research on the enlargement of whiteleg shrimp (Litopenaeus vannamei) DOC 90 using different pond shapes with an intensive cultivation system, the following conclusions can be drawn:

1. So it can be concluded that the different pond shapes with the DOC 90 intensive cultivation system have an effect on the production of vannamei shrimp.
2. The round pond showed higher production results, with an average production value reaching 894 kg compared to the square pond, while in the square pond the average production reached 758 kg.
3. Water quality conditions (water pH ranges between 7.5-8.3, water temperature ranges between 26oC-30oC, water salinity ranges between 20ppt-25ppt and dissolved oxygen ranges between 4.4ppm-5.7ppm) in all ponds are within the optimal range and do not have a significant effect on production results.

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