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Research Article

Comparison of Plankton Abundance, Water Condition, Organism Growth Performance of Vaname Shrimp (*Litopenaeus vannameiei*) on Intensive and Extensive Culture Systems in Banyuwangi Districts

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ABSTRACT

Litopenaeus vannameiei is one type of shrimp that is often cultivated in Indonesia. The culture system model consists of extensive (traditional) and intensive system. This study aims to determine the comparison of plankton abundance, water conditions, organisms growth performance of *Litopenaeus vannameiei* on intensive and extensive aquaculture systems in the waters of Banyuwangi Regency. The parameters measured are physical and chemical parameters including temperature, brightness, pH, dissolved oxygen, salinity, ammonia, alkalinity, type and abundance of plankton. The analysis method is plankton abundance, productivity analysis, SR, FCR and vaname shrimp growth. The results showed that 4 classes of plankton in intensive pond waters were identified namely *Chlorophyta*, *Cyanophyta* and *Chrysophyta* phytoplankton, while *Protozoa* class zooplankton. In traditional ponds not much different, there is only *Crpytophyta* class as an additional identification result. Plankton abundance in intensive ponds reaches 27,595 individuals per liter, while for extensive ponds plankton abundance reaches 37,641 individuals per liter. The survival rate of shrimp in intensive ponds is around 86% while extensive ponds are 67%. FCR value of extensive ponds 1.02, while intensive ponds FCR value of 1.17. The average final weight of shrimp on intensive ponds was 11.76 g/head and on extensive ponds which was 8.33 g/head.

Keywords: *Litopenaeus vannameiei*; Shrimp; Intensive; Extensive; Culture

INTRODUCTION

In Indonesia, shrimp farming has long been carried out by pond farmers. Shrimp is an excellent commodity in the field of fisheries that can increase the country's foreign exchange through the export of fisheries commodities. The high demand for shrimp inside and outside the country makes Indonesia the biggest shrimp shipper in the world. Indonesia has a wide area and the existence of natural resources that support to be able to develop shrimp farming [1].

Vaname is one type of shrimp that is often cultivated. This is because the shrimp have promising prospects and profits [2]. Vaname shrimp (*Litopenaeus vannameiei*) originates from the West Coast of the Pacific Latin America, from Peru in the South to North Mexico. Vaname shrimp began to enter Indonesia and was officially released in 2001. Vaname shrimp is one of the shrimp that has economic value and is an alternative type of shrimp that can be cultivated in Indonesia and is relatively easy to be cultivated. That also makes many shrimp farmers in the country in the last few years have been working on it [3]. Shrimp has a significant contribution to the national fisheries economy based on data from the International Trade Center in 2017.

Shrimp culture system consists of extensive (traditional) and intensive systems. The extensive (traditional) system still dominates the ponds of the Indonesian people. Extensive shrimp farming systems (traditional) are fishponds whose management system is totally dependent on natural generosity. The extensive (traditional) system is very simple so that its management is not complicated. The resulting production is low, ie between 50-500 kg/ha/growing season [4]. Whereas intensive ponds are ponds equipped with mulch plastic covering all parts or cement ponds, water pumps, waterwheels, aerators, high stocking rates and 100% pellet feed. Feed is a source of nutrition consisting of protein, fat, carbohydrates,

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vitamins and minerals needed by shrimp for optimal growth and development so that productivity can be increased. Vaname shrimp culture with intensive technology reaches high stocking densities ranging from 100-300 tails/m^2.

The controlled environment and cultivation with good waste management is expected to become a productive, profitable and sustainable vaname shrimp culture system. The effort that can be taken is to develop a shrimp production system that has a high level of productivity through the use of minimal pond land. Shrimp production targets are still faced with various challenges, one of which is aquaculture management that is capable of producing high levels of productivity [5].

The mechanism of the food chain in traditional shrimp pond aquaculture is that it is sourced from phytoplankton (plant-based plankton) whose position is as a primary producer of zooplankton (animal plankton) and subsequently eaten by fish and shrimp. A pond waters is said to be fertile if there are many primary producers in it, namely phytoplankton, both in quantity and quality as a source of natural food and also acts as an oxygen producer through the process of photosynthesis [6]. Stable pond waters environmental conditions are characterized by high plankton diversity, the number of individuals of each species is high and evenly distributed and the pond water quality is in the range by following the growth of aquatic organisms [7].

This study aims to determine the comparison of plankton abundance, water conditions, organisms growth performance of vaname shrimp (*Litopenaeus vannameiei*) in intensive and extensive aquaculture systems in the waters of Banyuwangi Regency.

MATERIALS AND METHODS

The materials needed include water quality parameters (Temperature, salinity, DO, pH, Alkalinity, NO_2^-, NO_3, Fe, NH_4, and TOM), plankton and vaname shrimp production. Measurement of these parameters was carried out in intensive and extensive ponds on the coast of Banyuwangi Regency.

Plankton and water samples are taken on intensive and extensive ponds that are under maintenance. Plankton is collected by filtering as much as 100 L of water compacted to 100 mL using plankton net number 25, then preserved with 1% Lugol solution. Water quality variables observed in ponds included temperature, pH, salinity, and dissolved oxygen, while nitrates, nitrites, ammonia, alkalinity, F and TOM were analyzed in the laboratory.

The research method used is descriptive method, which is to raise facts, circumstances, variables, and phenomena that occur now (when the research takes place) and present it as is. Further research using descriptive methods tells and interprets data relating to situations that occur and are experienced now, attitudes and views that are symptomatic now, the relationship between variables conflicting two or more conditions, influence on a condition, differences between facts, etc.

Data analysis

lankton abundance is calculated using the following formula:

$$N = n\ x\ \frac{Vr}{Vo}\ x\ \frac{1}{Vs}$$

N = Number of individual plankton (ind/L)

n = Number of plankton observed

Vr = Filtered plankton volume (ml)

Vo = Observed plankton volume (ml)

Vs = Volume of filtered water (L)

Performance of aquaculture performance measured are productivity, SR, FCR and vaname shrimp growth with the following formula:

SR (Survival rate) = Survival rate compared to when stocking (%) = (number of live shrimps/total stocking) x 100 %

FCR (Feed conversion ratio) = Total Feed: Total Amount of Harvest

Total Amount of Harvest = Total Stocking Solid x Average Weight

ADG (Average daily gain) = Daily weight gain in one period (10 days) = ABW II (grams) – ABW I (grams)/T (days)

ABW I = ABW in the first sampling (grams)

ABW III = ABW in the second sampling (grams)

T = The first and second sampling periods (days)

RESULTS AND DISCUSSION

Pond waters conditions

The main keys to water quality as life support media in pond waters include dissolved oxygen (DO), temperature, salinity and pH, while other life support, namely NO_2, NO_3, NH_4, Fe and TOM.

Looking at the comparison of water quality data available in Table 1, intensive pond temperatures are more stable than extensive ponds. It was triggered because the condition of extensive ponds was shallower. Salinity in intensive ponds tends to be higher because the majority of the pond system in Wongsorejo District uses seawater mixed with freshwater where the salinity of seawater in Wongsorejo reaches more than 30 ppt. Whereas for extensive ponds the majority of which are used in the Banyuwangi District close to the river so that salinity only ranges from 20-21 ppt.

Whereas for other water quality parameters there were no significant differences, only at higher Alkalinity in extensive aquaculture ponds. This is due to extensive cultivation using models such as sylvofishery where around the pond and in which

Table 1: Pond water quality of Banyuwangi Regency.

Water Quality	Observation Station	
	Intensive Pond	Traditional Ponds
Temperature (°C)	27,35	28,73
Salinity (ppt)	27,75	20,07
DO (mg/L)	4,55	5,44
pH	7,49	7,22
Alcalinity (mg/L)	189,78	239,49
NO_2 (mg/L)	0,01	0,04
NO_3 (mg/L)	0	0
Fe (mg/L)	0,04	0,05
NH_4 (mg/L)	0,06	0,52
TOM (mg/L)	74,26	61,5

there are mangrove plants. Mangroves themselves function as filters and sources of nutrients from water. Likewise with the value of NH_4, extensive ponds tend to be higher, considering the bottom of the pond is soil and there is no waterwheel, so that the rest of the feed and faeces of the shrimp themselves are collected at the bottom and there is no turnover or release into the air so that NH_4 is quite high when compared to intensive ponds who routinely use the wheel and periodically remove the basic water contained in the leftover feed.

Cultivation of one sector that operates in a water body, and managing many users in an integrated manner is important. Water is the most common property resource needed for aquaculture. Thus aquaculture systems need to maintain a minimum level of water quality and mitigate the impact of all resource users on the carrying capacity of an ecosystem. Seeing from the comparison of water quality between intensive and extensive ponds, for environmental sustainability both intensive and extensive farms are not different, both of these systems can be applied only depending on the characteristics of the waters themselves.

This can be seen from the temperature values for both types of ponds, where the temperature rise and fall that occured is still in the optimal range and is good enough for the growth and survival of vaname shrimp. This is consistent with the statement of Baliao and Siri in Amirna et al. which states that the ideal temperature conditions for the life of vaname shrimp are water that has temperatures ranging from 28 - 310C. The salinity value is still in the optimal range and still supports the growth and life of vaname shrimp. This is consistent with the statement of Nababan et al. [8] states that good salinity for growth ranges from 10 - 30 ppt. The variation of pH values during the maintenance of vaname shrimp between the two types of ponds is also not much different, this is caused by the waste from the rest of the feed that has been damped and decomposed which causes the pH of the pond water to rise. A decrease in pH was also seen in each pond plot. The decrease in pH is due to the water entering from the reservoir and the input of rainwater throughout the pond, but the decline does not occur spontaneously and does not affect shrimp production. The increase and decrease in pH that occurs is still in the optimal range and is ideal for the growth and survival of vaname shrimp. This is consistent with the statements of Iskandar et al. [9] and Amirna et al. which states that the normal pH value for vaname shrimp growth is in the range of 7.5 - 8.5. Whereas the dissolved oxygen value is still in the optimal range and is quite ideal for the growth and survival of vaname shrimp. This is consistent with the statements of Amri and Iskandar in Amirna et al. states that the dissolved oxygen content which is good for the life of vaname shrimp is 4 - 8 mg/l.

Plankton abundance

Plankton is a microorganism that lives in water and the plankton community is determined by the debit of water entering the water from the sea into the pond through the frequency of water change. This is evidenced by the number of genus plankton in intensive ponds more than in traditional ponds allegedly because the frequency of new water replacements in intensive ponds when conducting cultivation is more often done every three days using a pump, whereas traditional ponds new water replacement is only done at high tide that is, every two weeks, so that the large number of plankton genera in intensive ponds is determined by the frequent replacement of new water from the sea.

In general, in addition to changes in plankton abundance in pond waters, it is also accompanied by changes in the genus of plankton that fluctuate throughout the year. This is caused by natural factors and human activities. Plankton genus (phytoplankton and zooplankton) found in this study are shown in Table 2 and Table 3. The results of observations of plankton in intensive pond waters identified as many as 4 classes consisting of phytoplankton included in 3 classes, namely Chlorophyta, Cyanophyta and Chrysophyta, while zooplankton consisted of 4 classes consisting of phytoplankton included in 3 classes, namely Chlorophyta, Cyanophyta and Chrysophyta, while zooplankton consisted of 4 classes. from 1 class namely Protozoa. In traditional ponds not much different, there is only Crpytophyta class as an additional identification result.

Based on Table 2 and Table 3 above, although the variety of genus of plankton between intensive and extensive ponds is the same, it is seen from the amount of plankton abundance that is quite different. Plankton abundance in intensive ponds reaches 27,595 individuals per liter, while for extensive ponds plankton abundance reaches 37,641 individuals per liter. That is because the extensive ponds used are mangrove plants both around the ponds and in the ponds, so naturally, plankton in traditional ponds easily produce plankton abundance without having to be given treatment considering the nutrients available are enough to grow plankton.

Related to water quality in ponds, it will affect phytoplankton. As explained by Rahman et al. [10] that high and low abundance of

Table 2: Plankton obtained in the waters of intensive ponds in Wongsorejo District.

Category	Class	Genus	Abundance (ind./mL)
Fitoplankton	Chlorophyta	*Chlorella*	53.438
		Scenedesmus	2.500
	Cyanophyta	*Microcyste*	30.000
		Chaetoceros	80.000
		Anabaena	10.000
		Oscillatoria	16.250
	Chrysophyta	*Navicula*	2.500
Zooplankton	Protozoa	*Polytoma*	26.071
			27.595

Table 3: Plankton obtained in the waters of traditional ponds in Banyuwangi District.

Category	Class	Genus	Abundance (ind./mL)
Fitoplankton	Chlorophyta	*Chlamydomonas*	65.000
		Chlorella	98.625
		Chodatella	110.000
	Cyanophyta	*Oscillatoria*	10.000
	Chrysophyta	*Amphora*	10.000
		Navicula	2.500
	Crpytophyta	*Cryptomonas*	2.500
Zooplankton	Protozoa	*Polytoma*	2.500
			37.641

phytoplankton in water is influenced by environmental factors such as light, pH, temperature, and dissolved oxygen so that it will directly or indirectly determine the abundance of phytoplankton. As described in Table 2 and Table 3, there are differences in the abundance of phytoplankton, with extensive ponds tending to have a greater abundance of plankton than intensive ponds. This is because intensive ponds are in the area near the sea and far from rivers, and there are no mangroves as green lines and natural filters along the coast, rivers, main channels and between ponds. In contrast to extensive ponds in Banyuwangi it is close to rivers and the sea even in the area around the pond there are mangrove plants. According to Pirzan and Utojo, the preservation of the coastal environment through mangrove planting can protect pond conditions from abrasion, erosion and waste degradation.

It also affects the abundance of plankton species. For intensive phytoplankton ponds, the Cyanophyta class was found dominant from the beginning to the middle of the abundance cultivation period, this was due to the low N: P ratio where the measured N: P ratio from beginning to end of cultivation did not exceed 2: 1. Cyanophyta was an undesirable class because both of these classes can produce poison for shrimp. According to Lovell and Sacky in Widigdo and Wardiatno [11] that blue-green algae are capable of producing geosmin and 2-methylisoborneol which are then excreted into the water and absorbed by aquatic biota so that the cultivated organism smells unpleasant. Whereas for extensive ponds, the Chlorophyta class dominates the waters, because around the pond and in the pond there are mangrove plants so that the phytoplankton is easier to carry out photosynthetic processes so that the growth is quite dominating compared to other classes. Widigdo and Wardiatno explain that phytoplankton which are expected to grow in ponds are from the Chlorophyceae class because this class can be used as natural feed for shrimp in addition to being an oxygen enhancer in the water column.

Nevertheless, both types of ponds for phytoplankton abundance tend to increase with increasing time in one culture cycle due to the increase in nutrients resulting from the decomposition of organic matter. Salinity also increases with age. Evaporation that occurs during the day will make the salt levels in the pond increase because the volume of water decreases. When the water volume decreases, farmers add water from outside to maintain the depth of the pond. The condition of the water column depth is maintained at a minimum depth of up to 70 cm. This happens continuously so that the salt content in the pond increases until the end of the culture. According to Simon and Utojo, the growth of aquatic organisms primarily plankton will be better in ponds with a depth of more than 70 cm because plankton consists of living organs that are strongly influenced by surrounding conditions, so that at that depth a temperature will be reached in accordance with the necessities of life for fish, shrimp and plankton.

Vaname shrimp growth performance

The expected result of cultivation activities is a high survival rate so that maximum harvest production is obtained. Also, a large cultivation weight adds to the advantage in marketing. This is balanced with the use of feed. Feed efficiency during the maintenance period reduces the cost of cultivation to increase profits. Table 4 shows detailed pond data used and shows the growth performance of vaname shrimp during the maintenance period.

Table 4: Vaname shrimp cultivation data in each pond.

Parameters	Extensive	Intensive
Farm area (m^2)	1300	800
Amount of initial stocking	50.000	175.000
Stocking density (head/m^2)	38	218
Total feed (kg)	286	2068
FCR	1,02	1,17
ADG	0,1 gr/hari	0,5 gr/hari
SR (%)	67	86
Size (head/kg)	120	85
Culture Periods (days)	78	75

Survival rate is categorized as good if the SR value> 70%, for the SR category is 50-60%, and in the low category the SR value <50% (Widigdo, 2013). Based on this, the survival rate of shrimps in intensive ponds is around 86%, which means that it is in the good category, while in extensive ponds it is 67%, which means it is in the moderate category.

The results of intensive aquaculture processes for survival rates are in the good category while extensive ponds are in the moderate category. This is because the density does not take the maximum number so that the feed given can be put to good use by shrimps for more optimal growth, seen from the average weight gain at the end and the rate of shrimp growth during higher maintenance and good enough pond water quality. shrimp can still be tolerated for growth and survival. This is consistent with the statement of Yustianti et al. [12] which states that the factors that most influence the viability of shrimp are management in feeding and good water quality management in the maintenance media.

Then for the effectiveness of feeding it can be seen based on FCR calculations. Based on Table 4, it can be seen if the FCR value for ponds in Banyuwangi Regency is in a good category to be continued. An extensive pond FCR value of 1.02 indicates that to produce 1 kg of shrimp meat 1.02 kg of feed is needed, while intensive ponds FCR value of 1.17 is to produce 1 kg of shrimp meat 1.17 kg of feed is needed.

Regarding the shrimp growth performance according to Table 4, it is influenced by the density of shrimps that are kept. High density will increase competition in the place of life, food, and oxygen. So for intensive ponds, it must be balanced with appropriate technology considering the number of shrimp stocking is much higher than extensive ponds. From the results of the cultivation process, the FCR value in the vaname ponds by following with the FCR values generally ranging from 1.4 to 1.8. That is, farmers can minimize the cost of expenditure. This is consistent with the statement of Sopha et al. [13] that the smaller the FCR value the better because this indicates the smaller the costs incurred for the purchase of feed so that the higher the benefits obtained.

The growth of the average final weight of shrimp kept for 75-78 days shows results that vary from time to time in line with increasing time of maintenance. The average final weight of shrimp on intensive ponds was 11.76 g/head and on extensive ponds which was 8.33 g/head.

The average weight of shrimps obtained from the extensive system cultivation process that is at stocking densities of 38 individuals/m^2 obtained an average final weight of 8.33 g/head, during the 78-day maintenance life. While intensive cultivation, stocking density of 218 head/m^2 obtained an average final weight of 11.76 g/head, during the maintenance age of 75 days. Suwardi et al. in Tahe and Makmur stocking densities of 500 head/m^2 obtained a final average weight of 14.89 g/head. So that the growth of vaname shrimp is influenced by the stocking density, the higher the stocking density, the average weight of the shrimp decreases. Shrimp growth obtained due to competition in the media space of movement.

CONCLUSION

Plankton in intensive pond waters identified as many as 4 classes, namely phytoplankton class Chlorophyta, Cyanophyta and Chrysophyta, while zooplankton class Protozoa. In traditional ponds not much different, there is only Crpytophyta class as an additional identification result. Plankton abundance in intensive ponds reaches 27,595 individuals per liter, while for extensive ponds plankton abundance reaches 37,641 individuals per liter. While the survival rate of shrimp in intensive ponds is around 86% while extensive ponds are 67%. FCR value of extensive ponds 1.02, while intensive ponds FCR value of 1.17. The average final weight of shrimp on intensive ponds was 11.76 g/head and on extensive ponds which was 8.33 g/head.

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