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Production Performance of Super Intensive Vannamei Shrimp *Litopenaeus vannamei* at PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara

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Abstract

Vannamei shrimp (*Litopenaeus vannamei*) is one of the leading fishery commodities that have high economic value. If the process is implemented properly, shrimp production with a super intensive system becomes a profitable future of the aquaculture orientation. This study aims to examine the production process and product performance of super-intensive system vannamei shrimp on an industrial scale. This research method is a case study that includes observation, interviews, and directly follows the production process of shrimp on an industrial scale, without experimental design. The production process includes ponds preparation, media preparation, seed selection and stocking, management of feed and water quality, monitoring of pests and disease, monitoring of growth, and harvest. The treatment given was the application of *Bacillus* sp. as probiotics on rearing media to optimize shrimp growth. This study showed after 100 days of rearing resulted in SR 71%; biomass 8.96 tons; harvest size 45 – 32; ABW 22 g/tail; ADG 0.4 g/day; and FCR 1.6. Water quality was still in the optimal ranges to support of shrimp growth, includes: temperatures 27 – 31°C; brightness 14 – 120 cm; pH 7.4 – 8.6; salinity 33 – 34 mg/L; dissolved oxygen 3.8 – 5.5 mg/L; alkalinity 100 – 360 mg/L; TOM 40 – 103 mg/L; and nitrite 0.05 – 27.5 mg/L. The production process of vannamei shrimp on an industrial scale with a super intensive system that is applied by PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara shows optimal growth and yields.

INTRODUCTION

Aquaculture is one of the activities in increasing fishery production. Vannamei shrimp is one of the leading commodities in aquaculture (Hidayat *et al.*, 2019). Vannamei shrimp has very high durability and nutritional value, therefore the demand for vannamei shrimp is very large, both local and international markets (Rahman *et al.*, 2018). The volume of vannamei shrimp production in 2016 was 698,138 tons and experienced a significant decrease of 20% in 2017 to 555,138 tons (Suriawan *et al.*, 2019). Even in this condition of the COVID-19 pandemic, the need for vannamei shrimp exports to the U.S. market remained stable. Based on NOOA Fisheries (2020), it was recorded that the total export of Indonesia vannamei shrimp to the U.S. market in April 2019 was 9,544 MT (metric tons) and in April 2020 to 13,804 MT, which increases of up to 45%, which places Indonesia as the second largest of exporting country to the U.S. market.

According to Purnamasari *et al.* (2017), the advantages of vannamei shrimp are a high response to feed, resistance to disease, high survival rate, high stocking density, and relatively short maintenance time of about 90 – 100 days per cycle. The increased production of vannamei shrimp will continue to meet the demand community both at home and abroad. Various efforts have been made, especially through the development of aquaculture technology applications (Arsad *et al.*, 2018).

Vannamei shrimp production with super-intensive technology is the future orientation of aquaculture systems with the concept of low volume high density, that is by not requiring a large area so it was easily controlled, but has high productivity. The production target is still faced with various challenges, one of which is aquaculture management that can produce a high level of productivity. Therefore, shrimp production with a super intensive system can successful and profitable if the production process is applied properly.

This study aims to examine the production process and product performance of super-intensive system vannamei shrimp on an industrial scale that applied at PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara.

METHODOLOGY

Place and Time

This study was conducted from February to May 2020. The Location was in production ponds and Laboratory of PT. Sumbawa Sukses Lestari Aquaculture, Sumbawa Regency, Province of West Nusa Tenggara.

Research Materials

The tools used in this study were rearing ponds, paddlewheels, blowers, HDPE plastics, water quality measurement kit, digital scale, and net. The materials used in this study were vannamei shrimp seed, stress response test materials, quicklime, ZA fertilizer, *Bacillus* sp. as probiotics, commercial shrimp feed, and seawater.

Research Design

This research method is a case study that includes observation, interviews, and directly follows the production process of shrimp on an industrial scale, without experimental design that applied at PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara.

Work Procedures

This study consists of several stages of production, including pond and media preparations with an area of 3,025 m^2, selection and stocking seeds with a stock density of 250 tails/m^2, monitoring of growth, management of feed, management of water quality, monitoring of pest and disease, and harvest. The stages of this study refer to the Standard Operating Procedure (SOP) of vannamei shrimp production at PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara (Figure 1).

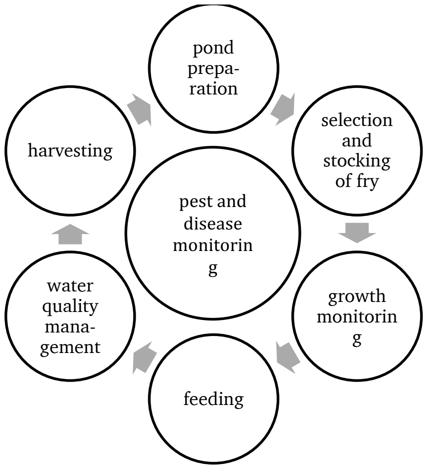

Figure 1. Flowchart of Standard Operating Procedure (SOP) for vannamei shrimp production at PT. Sumbawa Sukses Lestari, West Nusa Tenggara.

Data Analysis

Production performance parameters include survival rate (SR), biomass production, average body weight (ABW), average daily growth (ADG), and feed conversion ratio (FCR) refers to the method of Arsad *et al.* (2018). Water quality parameters observed during maintenance, include: temperature, brightness, pH, salinity, dissolved oxygen, alkalinity, TOM, and nitrite refer to the method of Pratiwi (2016).

Growth was observed by weight sampling, and the water quality parameters by measuring 2 times a day at 06.00 WITA and 16.00 WITA. A sampling of shrimp weight and water quality was carried out on the Day of Culture (DOC) 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 days. The data obtained were then tabulated using the application Ms. Excel to produce representative data in the form of graphs and tables and analyzed descriptively.

RESULTS AND DISCUSSION

Pond Preparation

The pond land used with size 55 x 55 x 2 m is covered with HDPE plastics. Pond preparation begins with drying the pond bottom for 7 – 10 days. Drying of ponds aims to speed up the oxidation process of residual organic matter, killing pathogenic bacteria, and pest organisms. The pond bottom needs to be cleaned of dirt such as moss, barnacles, oysters, and organic sludge leftover from the cycle previously. The barnacle was cleaned by scraping using the back of the brush. The pond walls are cleaned using a brush until clean, then sprayed using seawater from reservoirs. Pond equipment such as filters, paddlewheels, anco, anco bridges, canoes, siphons, and water levels are also cleaned to avoid contamination with disease-causing pathogens.

The pond construction inspection is carried out to find out any damage, such as: on sewer pipes, firing bases, harvest doors, and pond barriers. It was also important to check HDPE plastic to find out if there is damage at the joint or torn so that it can be repaired. Loose HDPE plastic connection or tearing has the potential to cause contamination of toxic compounds from below plastic that can cause mass death in shrimp. Farm plots are also installed with Crab Protecting Wall (CPW) to reduce pests that enter the pond plot. Liming is done after the cleaning process and installation of supporting equipment on the pond. The liming process is carried out by spreading lime evenly on the walls of the pond. The type of lime used is quicklime (CaO) with a dose of 300 kg.

The setting of paddlewheels and blowers aims to ensure a continuous supply of oxygen to the maintenance medium. Dissolved oxygen is one of the most important water quality variables for supporting shrimp life (Syah *et al.*, 2017). The installation of the paddlewheels also by placing 4 units of 1 HP paddlewheels at each corner pond. The operation of the mill is carried out throughout the day, while the blower is operated alternating from morning to evening and from evening to night. Blower installation is done by placing the blower in the blower housing and making connections for pipes that are placed at the bottom of the pond. Installation of this pipe forms a rectangle like the shape of a pond, then the pipes are given a small hole for the air outlet (diffuser). According to Sumitro *et al*. (2020), the use of diffusers can increase the survival rate of organism aquatic production.

Media Preparation

The filling of water into the reservoir pond used a seawater pump that was available at the pump house. Seawater that has been accommodated in a reservoir pond 150 m x 60 m deposited for 3 – 5 days, before being distributed to pond plots. Furthermore, seawater is distributed into aquaculture ponds up to a water level of 140 cm. The volume of seawater in the pond was 4,235 tons. The growth of plankton as natural food for shrimp is done by spreading ZA fertilizer 4.8 kg and 10 kg Azomite at 09.00 WITA. Then, at 17.00 WITA added probiotics, including 1 kg starter bacteria of *Bacillus* sp., 2 L molasses, and 2 L *Heroecobalance* (HEB), which has been diluted using water in a ratio of 1:4. The HEB treatment was given 2 days after the water entered the plot to grow a balance of microorganism populations in the pond ecosystem. According to Sumitro *et al.* (2020), the application of probiotics in forming biofloc systems in media maintenance can support optimal growth, survival, and FCR in aquaculture production.

Seed Selection and Stocking

The success of a shrimp production business was influenced by the quality of the seeds stocked in the pond. The seeds used were SPF vannamei seeds with stadia of PL 12 and an average of weight 1.93 ± 0.05 g/tail. The total of seeds stocked was ± 750,000 tails with a stock density of 250 tails/m^2. The production target is to produce shrimp harvest size 45 tails/kg with a maintenance period of 100 days.

Before stocking, seed selection is carried out through visual observation, such as appropriate body length, uniformity, seeds activity, and stress response. The stress response is known through the salinity test and formalin test which aims to see the level of seed resistance to a given stress factor. The salinity test was carried out by taking a sample of 100 tails seeds, then lowering the water salinity to 15 ppt for 30 minutes. The formalin test used a sample of 100 tails seeds that were put into a solution of 1 L water and 100 mg/L formalin.

The selected seeds will be put into an acclimatization tank with a volume of 1,000 L water and added with 2 ppm EDTA. Water quality conditions such as temperature, salinity, and DO are made similar to the condition of water in a plastic seed bag. Acclimatization is carried out at a constant temperature of 25 °C to reduce seed activity and yield toxic metabolism. This process lasts 15 – 30 minutes during this process will changes occur, namely a decrease in salinity and an increase in temperature in the acclimatization bath.

The rate of change of salinity and temperature was very important in the process of acclimatization. The PL stage and seed health conditions greatly affect the process of acclimatization, healthy and strong seeds can stand within salinity changes ≥ 20 mg/L and temperature changes ≥ 10 °C. The seeds that have gone through the acclimatization process will then flow through a pipe installed in the acclimatization tub to the pond plot.

Feed Management

Management of feed properly needs to be done, so that it can give optimal production results (Pratiwi, 2019).

Optimal feeding is given to support the growth of cultivated shrimp. Feeding can be done in two ways, such as: using an automatic feeder and manually spreading it using a raft. Feed management is important in making a feeding program so that ADG and FCR at harvest can match the target (Table 1). Feeding for DOC 1 – 30 by blind feeding. Feeding after entering DOC 31 until the harvest is determined by the target ADG method and the target FCR that has been determined programmed.

Table 1. Management of feeding on vannamei shrimp rearing for 100 days maintenance.

Feed Code	Type	D O C	Feeding Freq (times/day)	Feeding Time (.00 WITA)	Feeding Method
SA-00	Crumble	1 – 11	4	07, 10, 13, 17	Blind feeding
SA-01	Crumble	11 – 20	4	07, 10, 13, 17	Blind feeding
SA-02S	Crumble	21 – 25	5	07, 10, 13, 17, 22	Blind feeding
SA-02,SS-02	Crumble	26 – 35	5	07, 10, 13, 17, 22	Blind feeding, ADG target
SA-02SP	Pellet	36 – 50	5	07, 10, 13, 17, 22	ADG & FCR target
SA-02P,SS-02P	Pellet	51 – 70	5	07, 10, 13, 17, 22	ADG & FCR target
SA-03	Pellet	71 – harvest	5	07, 10, 13, 17, 22	ADG & FCR target

Feed control needs to be carried out to see how much feed is used up in one feeding. The procedure for adding or subtracting feed using 3 units available anco in the pond (Table 2). If in 3 units of feed given If all is used up, then the feed will be added by 30 – 50% of the feed program that has been implemented previously determined. The feed given to the anco unit is 0.5% of the total daily feed. This is following Ulumiah *et al.* (2020), the size and amount of feed given must be done carefully and precisely so that the shrimp do not experience a lack of feed (underfeeding) or excess feed (overfeeding).

Table 2. The procedure for determining feed on 3 anco units as a feeding control vannamei shrimp feed for 100 days of rearing.

No.	Anco Control			Feed Treatments
	(1)	(2)	(3)	
1.	-	-	-	added 30% of the previous feed
2.	S	-	-	added 30% of the previous feed
3.	S	S	-	fixed feed
4.	S	S	S	reduced 30% from the previous feed
5.	S	S	B	reduced 30% from the previous feed
6.	S	B	B	reduced 50% from the previous feed

Description: controls on 3 anco units are symbolized (-): the feed is depleted, S: the remaining feed is low (less than 50%), B: leftover feed a lot (more than 50%).

Water Quality Management

Optimal water quality is one of the requirements in cultivation activities. The quality of water in the maintenance container must be controlled to produce optimal seed growth (Pratiwi, 2014). The observed water quality parameters in this research, including temperature, brightness, pH, salinity, dissolved oxygen, alkalinity, TOM, and nitrite (Table 3).

Table 3. The results of water quality measurements on the vannamei shrimp rearing media for 100 days of maintenance.

Parameters	Units	In-situ results	Optimal Ranges	Reference
Temperature	°C	27 – 31	28 – 31	Arsad *et al.* (2017)
Brightness	cm	14 – 120	30 – 40	Kusuma *et al.* (2017)
pH		7,4 – 8,6	7,3 – 8,5	Makmur *et al.* (2018)
Salinity	g/L	33 – 34	33 – 34	Pratiwi (2016)
Dissolved oxygen	mg/L	3,8 – 5,5	3,5 – 7,5	Makmur *et al.* (2018)
Alkalinity	mg/L	100 – 360	50 – 300	Manan and Putra (2014)
TOM	mg/L	40 – 103	24 – 125	Pratiwi (2016)
Nitrite	mg/L	0,05 – 27,50	0,2 – 3,28	Parlina *et al.* (2018)

Based on the results of water quality measurement data, it is known that during maintenance, conditions of temperature, pH, salinity, dissolved oxygen, and TOM are according to the optimal range. Several other parameters, like brightness, alkalinity, and nitrite reached the limit of the range optimal due to maintenance that reaches DOC of 100 affects the condition of water quality. Overall, the water quality condition in this study is still in the optimal range in supporting the growth of cultured shrimp. Water quality management including lime and siphoning is carried out regularly to maintain optimal water quality conditions. Giving lime works to stabilize and raise the pH of pond water.

Giving lime is given upon entering DOC of 15 because the pH conditions have started to fluctuate. The type of lime used is quicklime (CaO), which was previously dissolved in a container filled with seawater and spread into the pond. The lime dose is adjusted to the pH measurement results at 06.00 WITA, that is if the water pH is< 8 as much as 25 kg, and water pH > 8 as much as 17 kg. Giving lime is also done when it rains because in that condition the shrimp experience stress due to fluctuations in media temperature. Drastic temperature changes are caused by water rain that enters the pond and causes a lot of molting shrimp. Moment molting shrimp will tend to be passive, susceptible to disease, and even die.

It fits with the research of Pratiwi *et al.* (2016), molting causes the condition of the lobster to be very weak and emits a fishy smell from the meat. This triggers cannibalism, which attracts the appetite of its predators, namely lobster healthy condition or not molting. Siphoning is very important to minimize the accumulation of effluent in the pond bottom. The more feed that is given to the pond, the more often siphoning frequency. Siphon treatment is carried out every morning at 09.00 WITA, which starts when the shrimp enter DOC 21. The siphoning technique in shrimp ponds is by opening the siphon pipe in the central drain area, then installing the net on the siphon drain pipe to find out the mortality of shrimp at the bottom pond. Late siphoning can cause infection with White Feces Disease (WFD), dirty gills, black spots, and other infectious diseases.

Pest and Disease Monitoring

Pests found during the rearing process were crabs and baby monitor lizards. The presence of pests can become predators for shrimp, resulting in low SR when harvest. Identification of diseases that attack shrimp was not found during the study takes place. However, the Total Plate Count (TPC) test found the presence of Vibrio *sp.* which is still within the normal range in the maintenance media samples. There are probiotics in maintenance media that can suppress the growth of *Vibrio* sp. which appears. This is following Fatmala *et al.* (2019), thet administration of probiotics on breeding media vannamei shrimp, optimal in suppressing the growth of *Vibrio* sp. cause of disease.

Growth Monitoring

Growth is a change in shape in terms of length, weight, and content according to changes in time (Pratiwi, 2014). Monitoring of shrimp growth is carried out by sampling the growth of shrimp weight during rearing. Sampling can also provide information to take preventive measures to avoid overfeeding or underfeeding.

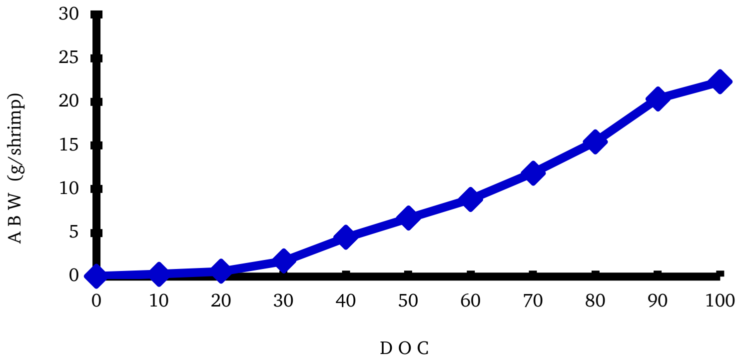

Figure 2. Growth of average body weight (ABW) of vannamei shrimp during rearing.

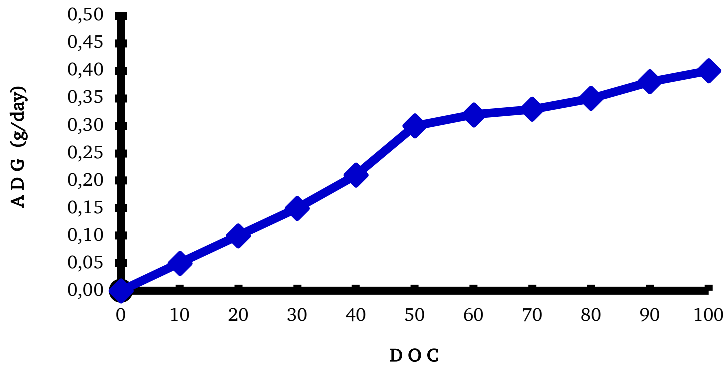

Figure 3. Daily growth rate (ABW) of vannamei shrimp during rearing.

Growing vannamei shrimp with a stocking density of 250 fish/m^2, at harvestable to produce ABW 22 g/head (Figure 2). This correlates with the value of ADG shrimp, each sampling continues to increase up to 0.40 g/day at harvest (Figure 3). According to Lailiyah *et al.* (2018), stocking densities 350-500 fish/m^2 in his research was able to produce ABW ranging from 10 - 14 g/head. Other research by Suriawan *et al.* (2019), the cultivation of shrimp with a stocking density of 100 fish/m^2 yields ADG 0.33 g/head. This indicates that shrimp growth is optimal during maintenance.

According to Pratiwi *et al.* (2016), growth in crustaceans is a change the increase in length and body weight that occurs periodically after molting. Molting occurs in animals with the exoskeleton, including lobsters where the old skin is removed and then replaced with a new skin. Factor affecting the occurrence of molting, among others: (1) external factors, namely environmental quality (temperature, salinity, or pH), nutrition, and post-acclimatization or transportation treatment, (2) internal factors, namely production of molting hormone (ecdysteroid) and Molt Inhibiting Hormone (hormone inhibiting molting).

Harvest

Harvesting is done partially and independently of DOC shrimp but pursued the target size of 45 – 32. Partial harvest was carried out twice, namely at DOC of 65 and DOC of 85. Before partial harvest, dry sampling was carried out to determine the ABW of shrimp to be harvested. This harvesting is done by spreading nets at the

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pointal ready determined. The total harvest is done by lowering the water slowly through the floodgate until it runs out, which is preceded by installing a waring (harvest bag) on the floodgate. If there is still water left in the aquaculture pond, the nets will be spread so that the shrimp contained in the pond is no longer left. The results of the wastewater from the harvest will be channeled to the waste collection tank, to maintain water quality used in aquaculture activities.

The total shrimp production in the research ponds showed an SR of 71%, biomass reaching 8.96 tons, harvest size 45-32, and FCR 1.6, and no fatalities caused by infection. According to Hidayat *et al*. (2019), vannamei shrimp rearing produces a range of SR 70 – 90% at harvest size 107 and early harvesting caused by an indication of Infectious Myonecrosis Virus (IMNV). According to Lailiyah *et al*. (2018), the vannamei shrimp rearing activities carried out showed the optimum FCR value ranged from 1.3 to 1.7. Based on the results of the total production, it shows that the cultivation of super-intensive vannamei shrimp enlargement by applying SOPs and actual conditions environmental quality supports optimal production performance.

CONCLUSION

The process of vannamei shrimp cultivation on an industrial scale with a super-intensive system that is applied by PT. Sumbawa Sukses Lestari Aquaculture, West Nusa Tenggara produces optimal shrimp harvest. Production performance of vannamei shrimp reared up to DOC of 100 has SR 71%, biomass as much as 8.96 tons, harvest size 45 – 32, ABW 22 g/tail, ADG0.4 g/day, and FCR 1.6.

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