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The Effect of Different Feed and Stocking Densities on Growth And Survival Rate Of Blue Swimming Crablets (*Portunus pelagicus*)

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Abstract. Blue swimming crab is targeted by commercial fisheries because of the high economic value, good taste, and attractive colors. As a result, the stock is overexploited and fisherman catch market also juveniles. The most sustainable solution would be to stop fishing for commercial trade and to culture this crab from brood to market size. This study aimed to find the best feed and stocking density for the on-growing of crablets. In 20 tanks juvenile crabs with a carapace width ± 1 cm were stocked in three densities; 40, 60 and 80 crablets /m², and fed ad-libitum twice a day with either trash fish or pellets of shrimp feed, for 8 weeks. The circular (≈ 1.6 m x 1 m) tanks with 1 m³ of water were aerated, and temperature, salinity, dissolved oxygen and pH recorded daily. In the end, growth and survival rates were determined. In general, feeding the crablets at a density of 40 m⁻² gave the highest growth. For crablest fed with pellets, the density of 40 m⁻² gave significantly better growth than 80 m⁻². The crablets at a density 40 m⁻² having a fish diet with the density 40 m⁻² grew better than 60 and 80 m⁻². There was no significant difference between feed used among different densities. The lower densities resulted in higher survival, either on crablets fed with pellets or fish. But, crablets fed the fish diet and cultured in the lowest density (40 m⁻²) had the highest survival rate.

Keywords. Feed, stocking density, blue swimming, crablet

1. Introduction

Blue swimming crab (*Portunus pelagicus*) is one of the fishery commodities exported mainly to the United States of America, which reaches 60% of the total catch of crabs. Landings of this crab in 2014 reached 212.571 tonnes [1]. Recently, crab commodities are ranked third or fourth of the total export value of Indonesian fishery products after shrimp, tuna, and seaweed. However, the number of blue swimming crab catch from the wild is declining now and the cultivation of this species is an alternative to be developed.

In term of developing culturing blue swimming crab, several studies have been conducted to develop of the crab aquaculture system, e.g, cannibalism [2], water quality requirement for BSC culture [3-5], diet and feeding behaviour [6-7]. Moreover, the introduction of the artificial hatchery and nursery *P. pelagicus* in Thailand [8] and Indonesia [9] is developing. For instance, the hatchery that developed



by Centre for Brackish Water Development and Cultivation (BBPBAP) Jepara has been successfully produced first crab stages in mass production. In this first crab

Stage, the megalops have metamorphosed to be young crab but is only 1/5 of an inch from point to point [10]. However, the successful cultivation of the next stage, i.e. at the stage of on-growing, has not achieved success yet. Factors of production and cultivation methods and also environmental influences that affect the successful cultivation of crab production for consumption size have not known for certain so far.

Growth in crabs is influenced by many things including given feed, stocking density, seed selection, proper cultivation techniques, and water quality and much more. Stocking density is one aspect of cultivation that needs to be known because it can affect the rate of growth, synthesis, and production levels [11]. Increased growth and survival of crabs can also be done through feed with a certain amount of protein or different types of feed. Feed is the main component needed by crabs to maintain its survival and growth. Nutritional equipment in the feed is absolutely necessary to keep the growth of crabs can take place normally. Nutritional requirements that include protein, fat, carbohydrates, vitamins and minerals for the growth of fish differ by type and size [12].

This study aims to determine the appropriate stocking and feeding density on growth performance and survival rate of blue swimming crab (*P. pelagicus*) which is cultivated in a tarpaulin tanks. This research is expected to contribute in the form of information to the community about the technical aspect of on-growing crab system.

2. Material and methods

2.1. Research location

This research was conducted from December 2016 to March 2017 in Brebes District, Central Java, Indonesia. The experimental station is located in Pandan Sari Village, in the sub-district of Kaliwlingi. For this trial, 20 tanks were used to test the effect of different feeds and stocking density on growth and survival rate of blue swimming crabs.

2.2. Research materials

The materials used in this research are young crabs (first crab stages) with size ± 1 cm length. The seeds were obtained from the Center for Brackish Water Development and Cultivation (BBPBAP) Jepara. The crabs are cultured with different stocking density and types of feed. Pellet which was used is pellet for culturing shrimp while the fish meat is trash product from fish processing which was called with "surimi"

2.3. Research design

The method used in this research is the experimental method using the Complete Design (RAL). The cultivated construction ponds were randomized and each treatment was repeated 3 times. The treatments provided are:

- A: 40 stocking density and pellet feed
- B: 60 stocking density and pellet feed
- C: 80 stocking density and pellet feed
- D: 40 stocking density and fish feed
- E: 60 stocking density and fish feed
- F: 80 stocking density and fish feed

The crab seeds that have been selected based on the size then weighed and then stocked based on the treatment used, i.e. with 40 ind, 60 ind, and 80 ind/m² and two types of feed, i.e. shrimp pellets and fish

meat (surimi). Furthermore, after being stocked the crabs were kept in a circular tarpaulin tanks with a diameter of ± 2.4 m and height of tank is ± 1 m meanwhile the water depth is 0.5 m

Crabs were fed with 5 % fix feeding of the total weight twice a day. Below is the proximate analysis comparing between of shrimp pellet and fish meat.

Table 1. Nutritional composition of pellet and surimi

PARAMETER	UNIT	<i>Pellet (dry weight)</i>	<i>Surimi (wet weight)</i>
Water	%	8.7	76.0
Ash	%	9.5	1.3
Fat	%	3.9	3.5
Protein	%	35.7	18.4
Fiber	%	4.9	0.1
Carbohidrat	%	37.3	0.7

Source. Center for Industrial Pollution Prevention Technology Laboratory result, 2017

2.4. Growth measurement

All crabs were weighed and measured (length) individually every two weeks. Weighing was done with the A&D® HL-100 electronic weighing scale with a precision of 0.01 g. The Total Growth (G) was calculated with the formula:

$$SGR = W_t - W_o \quad (1)$$

Where BW_t is the final body weight (g); BW_o is the initial body weight (g).

The specific growth rate (SGR) was calculated with the formulae:

$$SGR = \frac{\ln W_t - \ln W_o}{\ln W_o \times t} \times 100\% \quad (2)$$

Where SGR is specific growth rate (% BW day⁻¹); BW_t is the final body weight (g); BW_o is the initial body weight (g); and T is the duration of the experiment (days) [13].

The survival rate will be measured by counting the removed (residues of) dead crabs and counting during weighing. The survival rate (SR) will be calculated with the formulae:

$$SR = \frac{N_t}{N_o} \times 100\% \quad (3)$$

Where SR is the survival rate (%); N_t is the number of crabs collected at sampling time t; and N_o is the number of crabs initially stocked [13].

2.5. Water quality parameters

The following water quality parameters were recorded:

- Temperature (by using an electronic thermometer with a read-out precision of 0.1 °C) (twice daily 6 and 18 am)

- pH (by using HANNA® HI98129 pH meter with a precision of 0.01) (daily at 6 am)
- salinity (by using ATAGO® PAL-06S refractometer giving a precision of 1 ppt) (daily at 6 am)
- Dissolved oxygen (DO) (by using a YSI® Pro20 dissolved oxygen meter; read-out in 0.1 mg L⁻¹) (twice daily 6 and 18 am)

2.6. Data analysis

The data analyzes included total weight, total length, specific growth rate (SGR weight and length), survival (SR). The variables were obtained then analyzed using ANOVA. While the data about water quality was described descriptively.

3. Result

Growth rates of crabs (Table 1) were rather slow and final body weight ranged from 5.63 to 6.98 g among the different treatments. The highest final body weight was found in the tank which has density 40 ind and fed with fish meat (surimi), followed by a pellet in the same number of stocking density, while the lowest body weight was found in the tank which has 80 ind of stocking density which fed with a pellet. In terms of SGR, blue swimming crab cultured in 40 ind of stocking density also showed the highest result (2.6 %), while blue swimming crab cultured in 80 ind of stocking density showed the lowest (2.3 %), both of them fed by surimi.

Table 2. Growth of blue swimming crabs

TREATMENTS	Total growth		SGR		SR
	Weight (g)	Length (g)	Weight (%)	Length (%)	(%)
A (pellet)					
40	6.94 ± 0.3 ^{ab}	3.58 ± 0.2 ^{ab}	4.083 ± 0.1 ^a	2.547 ± 0.1 ^a	37.67 ± 26.6 ^a
60	6.33 ± 0.2 ^a	3.32 ± 0.1 ^a	4.079 ± 0.1 ^a	2.507 ± 0.04 ^a	21.67 ± 19.4 ^a
80	6.22 ± 0.6 ^{ab}	3.22 ± 0.5 ^{ab}	4.077 ± 0.2 ^a	2.446 ± 0.2 ^a	17.0 ± 7.9 ^a
B (surimi)					
40	6.98 ± 0.9 ^{ab}	3.64 ± 0.4 ^{ab}	4.103 ± 0.2 ^a	2.591 ± 0.1 ^a	31.33 ± 7.1 ^a
60	6.66 ± 0.4 ^a	3.18 ± 0.1 ^a	3.964 ± 0.1 ^a	2.416 ± 0.04 ^a	28.0 ± 25 ^a
80	5.63 ± 0.8 ^{ab}	3.01 ± 0.4 ^{ab}	3.796 ± 0.2 ^a	2.347 ± 0.2 ^a	24.0 ± 25.5 ^a

Different superscripts indicate significant differences ($P < 0.05$).

In brief, the total growth of crabs was influenced by stocking density but not influenced by the type of feed. Further, the total weights and length of crabs have a significant difference between stocking density treatments ($P < 0.05$) and crabs who treat in lowest stocking density have the fastest growth.

The water quality during the treatment was recorded in the following table.

Table 3. Water Quality

Parameters	Average
Salinity (ppt)	15 – 25
Temperature (°C)	20 – 30.3
Dissolved Oxygen (mgL ⁻¹)	3.3 – 4.8
pH	7.49 – 8.6
Amonia mg L ⁻¹	< 0.02

The amount of each water quality parameter above was appropriate to support blue swimming crab growth.

4. Discussion

4.1. Growth

The result of statistical analysis for the total weight and the total length of crabs gave significant effect ($P < 0.5$) between treatments but gave no significant effect for SGR. The highest total weight of crab is in the 40 stocking density and fed surimi, which was 6.98 ± 0.9 gram and the total weight of the lowest crabs is on the density of stocking of 80 ind and surimi was 5.63 ± 0.8 grams. The highest total length of crabs obtained in the treatment with stocking 40 ind and fed surimi (3.64 ± 0.37 cm) and the lowest total length obtained in treatment with stocking 80 and fed surimi (3.01 ± 0.4 cm).

The best stocking density for the cultivation of crabs found in this study is 40 ind /m². This is due to the cannibalism and crab required a wide range of motion. High stocking density will result in limited space and more competition in getting the feed and also the cannibalism of the crab increased resulted in mortality. According to Suharyanto and Tahe [11], stocking density affects competition against space, food needs, and environmental conditions which in turn can affect growth and synthesis that characterize production. The high stocking density will increase the risk of death and decrease the individual growth rate.

Growth is one of the important factors in the development of aquatic organism which can be seen based on the growth of increasing weight and length. Growth is the result of strong regulation between the factors contained in the environment, such as the availability of feed, temperature, photoperiod that will impact settings or metabolism in the fish body. Specific weight growth rate obtained during the treatment can be seen that the highest weight SGR value is obtained in 40 ind stocking treatment and fed surimi with the value of 4.1 ± 0.2 % / day, while the lowest value is obtained in 80 ind stocking treatment in the same feed that is equal to 3.8 ± 0.2 % / day. In addition, for the specific growth rate of length, it can be seen that the highest value of SGR is in the 40 stocking density and surimi fed is 2.59 ± 0.1 % / day, and for the lowest SGR value is obtained in the density of stocking 80 in the same feed that is equal to 2.37 ± 0.2 % / day. Differences in the growth rate of weights and width of crabs caused by the favorite of crabs in response to feeding. It is seen that crabs that consume surimi respond quicker than crabs which eat shrimp pellets. In nature, crabs are used to prey on live feed so the need to adapt when fed pellets. It affected the crabs who fed pellet have lower growth rate compare to crabs who eat surimi.

The existence of daily growth rate in the end observation indicates the existence of blue swimming crab. The growth means that the consumption of crab exceeds the energy needed for basic needs, such as maintenance and other body activities. Differences in the rate of growth are also thought to be caused by differences in feed digestion in the digestive tract associated with the amount of feed needed and the time to digest. According Suharyanto [14] states, that the frequency of feeding on fish will increase the rate of food flow in the digestive tract. In addition to the digestibility of food that causes growth differences are also caused by the quality of the food itself.

4.2. Survival rate

The survival rate is the parameter of the success of a cultivation activity. The survival rate is a comparative value between the numbers of early organisms when the dispersion is expressed in percent where the greater the percentage value indicates more organisms that live during maintenance [15].

The survival rate of crabs is still low, ranging from 17% - 37%. It can be influenced by many things, including the quality of seeds, the stocking density, water quality maintenance media, surrounding environment and disease. Currently, the very low crab survival rate is one of the obstacles to the

cultivation of small crabs. The main constraint in the cultivation of crabs is the low life graduation rate is around 4% -29% [16].

4.3. Water quality

Water quality management of maintenance media is very important to note because it affects the growth during cultivation period of crabs. Water quality has an influence on the physiological balance of the fish body. The dissolved oxygen level (DO) on during the experiment was 3.3 to 4.8 mg / L due to adequate aeration. This value was still in reasonable range because according to Susanto et al. (2006) the decent range is 4.5-6 mg / L. The pH value during the study took place as much as 7.49 – 8.6. According to Susanto et al. [17], the pH value of a decent range of 8-8.5. Incorrect acidity (pH) values can lead to stress crabs, decreased metabolism, slow growth, and death.

The temperature on maintenance media is 27,2-31,9°C, the value is still in the unsuitable range for the crab because the temperature is 28-34°C [18]. An increase in temperature can lead to an increase in the rate of metabolism and respiration of aquatic organisms. The coastal area in Brebes district are found at temperatures ranging from 27 ° C to 30 ° C, salinity 30 ppt to 33 ppt and water depths ranging from 3 m to 12 m with substrate conditions dominated by sand fractions, mud fractions and clay fractions [19].

Salinity on maintenance media ranges from 15 - 25 ppt. This value is considered feasible because of the optimal value for the cultivation of crabs according to Erlinda et al.[20], salinity for crabs ranges from 30-40 ppt. This low salinity is one of the causes of the low lifespan of crabs. According to Chande and Magya [7], that crabs can survive up to 9 ppt salinity. But if the salinity is always low will cause mortality because it does not reach the optimal value so that the crab metabolism will also be disrupted. The low salinity is caused by continuous rain so that the water source from the pond becomes brackish and the salinity continues to decline.

Ammonia levels in the media during this study were 0.1 – 0.2 mg / L. The ammonia levels are still feasible for culturing crabs. According to Serang [21], in general, the concentration of ammonia in water should not be more than 1 mg / L. Ammonia concentrations of 0.4 - 2 mg / L in a short time can cause death in fish. The degree of ammonia toxicity is affected by the pH and temperature of the aquatic environment, where the ammonia concentration increases with increasing pH and temperature.

5. Conclusion

The difference of stocking density gave significant effect for total growth, both of weight and length but the type of feed given did not have a significant effect ($P > 0,5$) on total weight growth, total length, SGR weight, and survival of crab seeds. Both of shrimp pellet and the surimi can be used for survival rate and growth of blue swimming crab.

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