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GROWTH OF INDONESIAN GIANT FRESHWATER PRAWN (*Macrobrachium rosenbergii*) IN A CLOSED AQUACULTURE SYSTEM WITH ARTIFICIAL SHELTER

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ABSTRAK

Udang galah merupakan organisme perairan yang bersifat bottom feeder*. Tingkah laku udang ini yang kanibal menuntut ruang gerak yang cukup untuk hidupnya. Makin besar ukuran udang makin luas ruang gerak yang diperlukan. Penelitian ini bertujuan untuk membuktikan bahwa pertumbuhan udang galah pada sistem resirkulasi berhubungan dengan keberadaan pelindung buatan. Percobaan dilakukan menggunakan 12 akuarium yang terhubung dengan satu unit filter biologis sehingga membentuk sistem resirkulasi. Penambahan air dilakukan tiap hari untuk menjaga kehilangan air akibat evaporasi. 50 % kolom air diisi dengan pelindung buatan dari bambu yang dirancang menyerupai kerangka bilik sebuah bangunan apartemen. Pelindung ini berfungsi sebagai tambahan ruang bagi udang yang dipelihara untuk tempat menempel/bertengger. Udang dipelihara di dalam sistem yang dipasangkan apartemen dan tanpa apartemen, serta pada berbagai kepadatan tebar. Sistem resirkulasi dengan 50 % apartemen dapat dipakai untuk memelihara udang galah yang menghasilkan performa pertumbuhan yang baik.*

Kata kunci : pelindung buatan, udang galah, pertumbuhan, *macrobrachium rosenbergii*

ABSTRACT

Giant freshwater prawn is a bottom feeder aquatic organism. Cannibal behavior of this prawn requires more space for its life. The bigger the size of the animal is, the wider space is required. The aim of this experiment is to reveal the growth of giant freshwater prawn cultured in recirculation system equipped with artificial shelter. The experiment was conducted by using 12 aquaria connected to biological filter to recycle the culture media water; however water addition was still performed every two days for to maintain water loss due to evaporation. Fifty percent of the water column was filled with artificial shelter made of bamboo arranged like an apartment structure. This shelter performs as additional space for the prawn to attach. Prawns were cultured in closed recirculation system equipped with an apartment with different stocking density. The closed system with 50 % apartment could be used for culturing giant freshwater prawn with good growth performance.

Key words : artificial shelter, giant freshwater prawn, growth, *Macrobrachium rosenbergii*

INTRODUCTION

Development of Indonesian giant freshwater prawn *(Macrobrachium rosenbergii)* culture in Indonesia is still relatively new. Research on culture techniques of the prawn in Indonesia have started since 1970. The first person to introduce this prawn in Indonesia was Mr. Sachlan, a plankton expert and a crustacean taxonomist, in 1950. He predicted that this prawn would have a big economic potency in the future. Techniques of culturing the prawn were first developed in sawah-tambak (paddy fish) in Lamongan, East Java and in fish pond in Tasikmalaya and Ciamis, West Java during 1970s.

Fish farmers in Yogyakarta have started culturing the prawn since 1984. They

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obtained the prawn seed from BBAP (Brackish water Aquaculture Station) in Jepara, Central Java. Bali entrepreneurs have also operated the giant prawn farms around Klungkung, Singaraja, Bangli and Tabanan. They bought the prawn seed from Klungkung or from private hatchery in Yogyakarta. Later on, increasing internatio-nal demand which exhausted the natural stock had encouraged the development of this prawn cultivation activities (FAO, 1999 and 2000). Nowadays, culturing of giant prawns has been developed intensively. Development of culturing technique of giant prawn in ponds has been carried out by Sabar & Ali (2001).

Despite the vast developed; the main problem in giant prawn culture is low productivity of culture (100–200 kg/1000 m^2). Moreover, land area that suitable for prawn culture is limited and the availability of water resources both in terms of quantity and quality is also often insufficient. Six month period of dry season in Indonesia often creates problem due to low debit of water resources. These problems require a technological solution that can help farmer to produce prawn more productively in the same area of pond.

The artificial shelter application in giant freshwater prawn culture was initiated by Ling (1969). Beside shelter function, the artificial shelter also provides hiding places for the prawns, especially during their molting periods to reduce the risk of cannibalism. In this experiment artificial shelter (prawn apartment) was apllied in a closed recirculation system to grow fresh water giant prawn *(Macrobrachium rosenbergii)* which is aimed to investigate the prawn survival rate and growth. The expected results of this study will hopefully answer recent problems faced by farmers to improve the prawn production in a limited pond area and water resources.

MATERIALS AND METHODS

The experiment was conducted using closed aquaculture system consisting of 12 aquaria equipped with a biological filter unit. A pump (Panasonic Model GP-125JB, China) was used to recirculate water with a flow rate of 30 l/min. Aquaria dimension were 80 x 40 x 40 cm^3. The biological filter unit was consisted of 3 plastic tanks, each with 100 l volume, 40 cm diameter and 75 cm height. Bioballs with diameter of 3 cm were loaded into one of the tanks made a 10 cm layer on the tank bottom. Zeolite crumble with grain size of 0.5 cm made the second layer of up to 5 cm height, and then pelletized active carbon (2 mm diameter; 5 mm length) placed above it with a height of 5 cm. The tanks were filled with water to a volume of 75 l. These tanks were designed as organic matter sedimentation tank which provide substrates for nitrogenous bacteria to grow and utilize wastes produced by cultured prawn and excess feed.

Water was flowed into the aquaria up to 32 cm height and passed out gravitationally into the filter tank, then entered the reservoir tank and pumped back to the aquaria. Prawn culturing aquaria were equipped with an arrangement of bamboo slices (1.5 cm width) set alike an apartment structure with the length, width, and height proportion of each frame of 10 cm. The structure consisted of three stairs where 50% of the volume of each aquarium had a prawn apartment with 27 compartments (Figure 1). The pump discharged water at a flow rate of 30 l/min. This flow rate was maintained to flow water into each aquarium with relatively equal distribution flow rate of 2.5 l/min to give water retention time in the aquarium was 40.8 min. There was no water replacement during experiment but to compensate the evaporation loss.

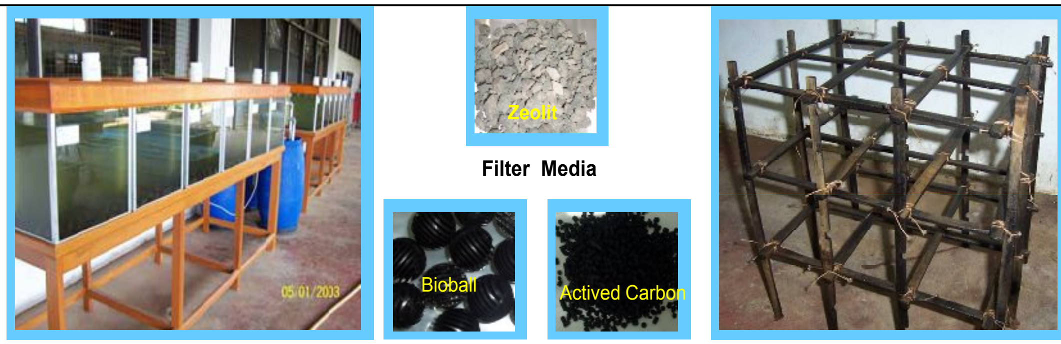

Figure 1. Experimental Prawn Closed Aquaculture System with Apartment like Artificial Shelter

A complete random design was applied in this experiment (4 treatments with 3 replications). Giant freshwater prawn seeds with average length of 6.54 $\pm$ 0.27 cm and average weight of 2.32 $\pm$ 0.24 g were used to stock the aquaria according to the treatments, which were 5, 10, 15, and 20 prawns per aquaria. These densities are equivalent to 50, 100, 150, and 200 prawn/m^2, respectively. The prawns were then cultured for 75 days. The lowest stocking density of 5 prawns/aquarium (50 individuals/m^2) was set above those of traditionally prawn culture conducted by local farmers around Bogor which usually stock 15 individuals/m^2 of the same size prawns.

Water quality was monitored regularly. Dissolved oxygen was measured titrimetrically by Winkler's method of APHA (2002). Water temperature, pH, turbidity, and conductivity were measured using Water Quality Checker (WQC) HORIBA U-10, Japan. Ammonium-N, Nitrite-N and Nitrate-N were analyzed by means of spectrophotometer following the standard method of APHA (2002). The prawn growth was measured every 15 days and mortality was observed daily. The recovery rate of juveniles was calculated using the following formula:

RESULT

The experiment shows a better prawn culture performance during 75 days rearing in a 50 % coverage prawn apartment closed recirculation. The prawn with average of 2.2 – 2.4 g weight and 6.4 – 6.7 cm length grew up to 5.0 – 7.5 g and 7.8 – 8.9 cm. The prawn survival rate was relatively high (>77.8 %), while the stocking rate also improved up to 20 individuals/aquarium or similar to 200 individuals/m^2 of pond (Table 1).

The presence of 50 % coverage of prawn apartment in the aquaria were able to reduce the prawn mortality. Prawn could utilize the apartments as attaching place and temporary settling during culturing (Figure 2) thereby improving the survival rate of prawn. The highest survival rate (100%) was observed at the lowest stocking density (Treatment I). Treatment II, III and IV gave the survival rate as high as 86.7, 77.8 and 80.0 %, respectively (Table 2). The results suggests that stocking density affected the comfortable of the prawn in the system. Treatment III showed lower survival rate than treatment IV, but statistically it was not significantly different.

$$\text{Juvenile recovery rate (\%)} = \frac{\text{No of juvenile at the harvesting}}{\text{No of PL at the stocking}} \times 100$$

Feeding was given ad-*libitum* with feeding frequency of twice daily.

Table 1. Stocking and Harvesting of Prawn with 50 % Prawn Apartment at Different Stocking Density

Stocking and Harvesting	Treatment			
	I	II	III	IV
Stocking	Density 50/m^2	Density 100/m^2	Density 150/m^2	Density 200/m^2
Mean length (cm)	6,7	6,5	6,6	6,4
Mean weight (g)	2,2	2,4	2,4	2,3
Number /m^2	50	100	150	200
Number/ aquarium	5	10	15	20
Harvesting				
Mean length (cm)	8,9	8,3	8,4	7,8
Mean weight (g)	7,5	6,0	6,1	5,0
Mean recovery rate (%)	100	86,7	77,8	80,0

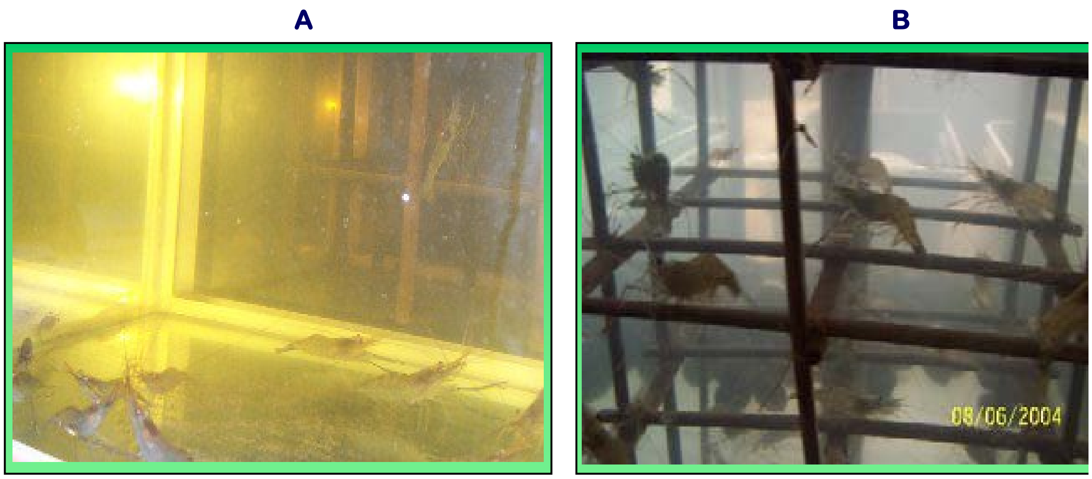

Figure 2. Prawn Response to the Presence of Artificial Shelter. Left is Prawn Without (A) and Right with Shelter (B)

Table 2. Survival Rate of the Prawn with 50 % Prawn Apartment at Different Stocking Density During Experiment

Time (days)	**Treatment**			
	I	**II**	**III**	**IV**
	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}	100.0 ^{a}
15	100.0 ^{a}	96.7 ^{a}	95.6 ^{a}	93.3 ^{a}
30	100.0 ^{a}	90.0 ^{b}	93.3 ^{b}	91.7 ^{b}
45	100.0 ^{a}	86.7 ^{b}	86.7 ^{b}	85.0 ^{b}
60	100.0 ^{a}	86.7 ^{b}	80.0 ^{b}	85.0 ^{b}
75	100.0 ^{a}	83.3 ^{b}	77.8 ^{c}	80.0 $^{b\,c}$

Values with different letters are significantly different at 95 % CI

The stocking density also affected the prawn growth (both weight and length). The higher the stocking density was, the lower the growth rate of the prawn. This condition was observed after culturing period of 30 days. Treatment IV, the highest stocking density of 200 individual/m^2, had a significant difference of weight growth from treatment I and II, but it was not significant different from treatment III. At the end of the experiment, the lowest stocking density (treatment I) showed the highest individual growth yield (7.50±3.43 g) compared to other three treatments (treatment II, III, and IV) with average individual weight of 6.04±3.38 g, 6.09±3.44 g and 5.02±2.72 g, respectively. Figure 3 show that giant freshwater prawn with the lowest stocking density had the highest growth rate during the experiment.

Similar trend was also observed on the length growth of the cultured giant freshwater prawn. The difference of length growth was observed after day-15 where the lowest stocking density (treatment I) gave the highest growth. However, stocking density of 100, 150 and 200 individuals/m^2 did not show different length growth. At the end of the experiment, prawn individual length for treatment II, III, and IV were 8.33±1.37, 8.40±1.27 and 7.83±1.07 cm, respectively (Table 3).

Despite the lower growth and survival rate, however, the higher harvest yields were consistently obtained with the stocking density. Harvest yield from this experiment could be grouped based on stocking density. Low stocking density (50 individuals/m^2) was observed to achieve a significant lower yield than those of high stocking densities (100, 150, and 200 individuals/m^2). Stocking density of 150 and 200 individuals/m^2, however, showed to produce similar yields. Therefore, an information can be inferred from survival rate and total biomass data of this experiment that prawn stocking of 200 individuals/m^2 in a pond equipped with 50% apartment resulting twice more yield compared to that of 50 individuals/m^2 (Table 4).

Water quality in the closed aquaculture system was relatively stable during the experiment (Table 5). Water pH was ranged between 8.20 – 8.25, dissolved oxygen was 5.17 – 5.70 mg/l, and temperature was 24.70 – 26.7 ºC. Ammonium-N, Nitrite-N and Nitrate-N concentrations were also at an acceptable range to support the growth of the prawn. Ammonium was below 0.002 mg/l, Nitrite was 0.043 - 0.0076 mg/l, and nitrate was 4.841 – 5.288 mg/l.

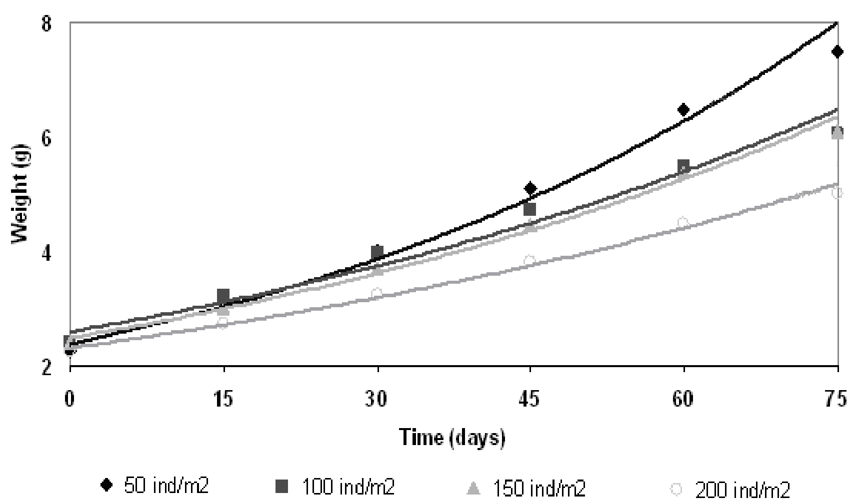

Figure 3. Weight Growth of Prawn (g/individual) During Experiment.

Table 3. Individual Length (cm) of the Giant Freshwater Prawn During Experiment.

Time (days)	Treatment			
	I	II	III	IV
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
0	6.67±0.50 ^{a}	6.53±0.73 ^{a}	6.63±0.67 ^{a}	6.37±0.80 ^{a}
15	7.27±0.83 ^{a}	7.07±0.83 $^{a\ b}$	7.07±0.80 $^{a\ b}$	6.77±0.87 ^{b}
30	7.83±0.90 ^{a}	7.63±0.93 ^{a}	7.47±0.93 $^{a\ b}$	7.07±0.97 ^{b}
45	8.27±0.97 ^{a}	8.00±1.10 ^{a}	7.87±1.03 ^{a}	7.47±1.03 ^{b}
60	8.60±1.27 ^{a}	8.10±1.10 ^{a}	8.13±1.27 ^{a}	7.73±1.07 ^{b}
75	8.93±1.33 ^{a}	8.33±1.37 ^{b}	8.40±1.27 $^{a\ b}$	7.83±1.07 ^{b}

Values (means ± SD) with different letters are significantly different at 95 % CI

Table 4. Prawn Biomass During Experiment.

Time (days)	Treatment			
	I	II	III	IV
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
	I	II	III	IV
0	112.3+20.3 a	238.8+26.6 b	359.5+29.5 c	450.1+18.0 d
15	154.2+21.2 a	309.5+32.8 b	433.7+38.4 c	501.4+23.9 d
30	199.9+24.9 a	357.5+43.6 b	529.9+5.0 c	592.7+72.3 c
45	251.6+6.1 a	403.9+41.4 b	580.2+27.0 c	649.1+69.0 c
60	324.2+22.8 a	455.3+45.5 a	645.5+14.5 b	765.5+80.3 b
75	375.2+29.6 a	500.9+42.1 b	730.3+18.1 c	802.7+44.6 c

Values (means ± SD) with different letters are significantly different at 95 % CI

Table 5. Water Quality in the Aquaria During Experiment

Parameters	Day 0	Day 15	Day 30	Day 45	Day 60	Day 75
pH	8.21±0.02	8.20±0.01	8.25±0.02	8.25±0.02	8.25±0.02	8.25±0.02
Conductivity ($mS.cm^2$)	9.00±0.01	9.53±0.07	9.63±0.01	9.63±0.01	9.63±0.01	9.63±0.01
Turbidity (NTU)	1± 0	1± 0	1± 0	1± 0	1± 0	1± 0
DO (mg/l)	5.70±0.02	5.17±0.17	5.49±0.20	5.49±0.20	5.49±0.20	5.49±0.20
Temperature (^oC)	26.51±0.03	26.70±0.03	24.86±0.05	24.86±0.05	24.86±0.05	24.86±0.05
NH_4 - N (mg/l)	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
NO_2 – N (mg/l)	0,0043±0,0004	0,0076±0,0013	0,0060±0,0007	0,0049±0,0007	0,0051±0,0003	0,0059±0,0008
NO_3 – N (mg/l)	5.116±0.158	5.288±0.189	5.135±0.256	4.891±0.202	4.896±0.125	4.841±0.307

DISCUSSION

This experiment proved that prawn could be cultured in a limited area and water in a closed recirculation system that capable to maintain the water quality and quantity for the prawn growth. The closed system was able to maintain the water quality at the optimum growth condition under daily feeding and no water replacement. It was shown that the performance of biological filter with ratio of 1:6 (composition of filter : culture tank) was good and still capable of treating organic sewage came from excessive feed and prawn excretion.

The prawn apartment in this experiment was very useful to reduce mortality or to maintain survival rate of the reared prawn. Even in the stocking density as high as 200 individuals/m^2, it could give survival rate up to 80 %. This value was remarkable higher than that of previous study in tanks without apartment which reported only had average harvest of 40 prawns/m^2 (26.7 %) (Ali, 2004). This value was also higher than that of study by Nabi *et* *al.* (1999) using tank without apartment in which the survival rate of prawn post larvae (PL) only reached 31.8% with initial stocking of 200 individuals/m^2 during 76 days experiment.

It has been reported that artificial shelter in giant freshwater prawn culture has function both as hiding places from predator, particularly in the molting time (Ling, 1969; Tidwell *et al.* 1998; 1999; 2000). Sripatrprasite & Lin (2000) suggested that the prawns should be stocked in suitable places with natural shelters in order to prevent predation and to provide rich feeding grounds. Furthermore, nursing PL to juveniles prior to stocking them would increase the survival rate. The type of material and dimension of artificial shelter should also be considered, because not all types of material and dimension are suitable for the prawn. Mariappan & Balasundaram (2003) reported that the size of the shelter selected by prawn *Macrobrachium nobilii* was directly related to its body size. They said that regarding to the choice of the color of the shelter, juveniles and adults of this prawn preferred dark shelters over light-colored shelters and never choose a transparent shelter. In this experiment, shelter from bamboo which had dark color and the size that was suitable for reared prawn was used and showed good performance for the prawn.

An experiment on artificial shelter using material from PVC with fencing form also had been conducted in Kentucky State University for the same purpose. The shelter could increase the harvest above 1800 kg/ha/crop with initial stocking of 4 PL/m^2 (New, 2002). Since stocking PL in ponds give a high risk of mortality, Tidwell & D'Abramo (2000) suggested that it would be better to stock juvenile stage at 6.5 individuals/m^2 (65,000 individuals/ha) in ponds equipped with shelter to produce prawn more than 2500 kg/ha/crop.

Giant freshwater prawn growth in this experiment was closely related to stocking density of cultured prawn. Low stocking density gave the high average growth. Faster average growth were observed in the lower stocking density of cultured prawn, however, the stocking of 100 and 150 individuals/m^2 did not show significant weight differences. In the case of using prawn apartment, the lower the stocking density, the lower average yield was, although stocking of 150 and 200 individuals/m^2 did not show significant yield difference. While Ling (1969) found the prawn survival and harvest weight by about 25%, in this experiment, the yield was about 100% by using the apartment and high density of prawn. It proved that apartment provided additional area on the pond bottom for prawns to live on and helped increasing survival and harvest.

CONCLUSION

It can be concluded that:

1. Closed aquaculture system could support a good growth performance of giant freshwater prawn culture;
2. Application of prawn apartment at 50% coverage reduces the prawn mortality down to as low as 0 % in the culture with density of 50 individuals/m^2.
3. Even though the stocking density reduces the prawn survival rate growth rate, it increases the harvesting yields. The highest yield was obtained at the density of 200 individuals/m^2 and followed by those of 150, 100 and 50 individuals/m^2.

This study shows that a high productivity giant fresh water prawn culture could be performed in a limited area and water by means of a closed aquaculture system provided with artificial shelters (prawn apartment).

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