Effect of substrate on growth, survival and moulting in Juvenile Red Claw, *Cherax quadricarinatus*

Siti Nor Fatihah[1]*, Harman Muhd-Farouk[3,4], Nurul Ily Izyan Raduan[2], Lim Leong-Seng[2] and Mhd Ikhwanuddin[4]

[1]Department of Agrotechnology and Bio-Industry, Politeknik Jeli Kelantan Jalan Raya Timur Barat 17600 Jeli, Kelantan, Malaysia. [2]Borneo Marine Research Institute, Universiti Malaysia Sabah, Jalan UMS 88400 Kota Kinabalu, Sabah, Malaysia. [3]FRI Batu Maung, Department of Fisheries Malaysia, 11960 Bayan Lepas, Pulau Pinang, Malaysia. [4]Institute of Tropical Aquaculture, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia.

Abstract: The experiment was conducted to determine the effects of different substrate on the survival, growth and total number of moulting in juvenile red claw, *Cherax quadricarinatus* for aquaculture purposes. In the present study, there is a problem in culturing juvenile stage of *C. quadricarinatus* especially for survival and growth. Thus, a substrate was used to improve the survival and growth of *C. quadricarinatus* especially for the intensive system due *C. quadricarinatus* need a large space to survive. *C quadricarinatus* with initial body weight from 1.10 to 2.90 g, total length 2.82 to 4.36 cm were placed in tanks (80 L in volume capacity) with 55L in water and there are eight juveniles in each tank. Treatment tanks were introduced with coral as treatment 2 and pipe as treatment 3. While, tank without shelters was set as control (treatment 1). Black nets were installed on top of each for circumventing foreign objects enter the tank and protect from direct sunlight. Besides, *C. quadricarinatus* were acclimatized for seven days before started the experiment. The experiment was done in duplicate and conducted for 60 days and *C. quadricarinatus* were fed twice daily (morning and evening) based on 5% of body weight. From the total of two replications, *C. quadricarinatus* for treatment 2 (coral) were significantly in survival (81.25±8.84%), weight gain (347.36 ±6.04%), specific growth rate (2.50±0.02%), carapace length (32.93 ± 0.93 %) and total number of moulting (55.00±2.93%) compared to other treatments. Besides, the control treatment (treatment 1) has a lower percentage in survival (37.50±8.84%) weight gain (122.60±20.51%) specific growth rate (1.33±0.15%), carapace length (25.84±0.33 %) and total number of molting (29.00±0.71%). As a conclusion, usage of coral as the substrate in the rearing tank showed improvement in survival, weight gain, specific growth rate, carapace length and total number of molting in *C. quadricarinatus*. The coral can use in rearing tank for increase the growth and survival for a small scale and not for commercial. In addition, in the environmental aspect, the present study showed the benefit of replacing the use of PVC pipes with the natural structure of dead coral.

Keywords: *Cherax quadricarinatus*, red claw, substrate, survival, growth, moulting.

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* **E-mail:** fatihah@pjk.edu.my | **Phone:** +609-9443600 ext. 677

I. INTRODUCTION

There are more than 600 species of freshwater crayfishes worldwide except in continental Africa, the Indian-subcontinent and Antarctic while every year more species are being well-defined [1-5]. Besides, there are more than 100 species of Australian crayfishes, but only three species of the genus *Cherax* are presently being farmed due to their high marketable potential. These are *Cherax tenuimanus* (Smith), *Cherax destructor* (Clark) and *Cherax quadricarinatus* (von Martens), which is native to the rivers of northen Australia [6]. Through recent decades, the worldwide success of the freshwater crayfish aquaculture industry has been based on the variety of species with sufficient characteristics for culturing and commercial purposes [6].

Cannibalism is one of the main causes of low survival in many aquaculture species especially for juvenile or larvae stage that inhibits the aquaculture industry. Alike problems were reported in different species of crayfish in the early stages of life and agonistic behaviour and cannibalism are main reasons for reducing yields in different culture systems [7-10] Furthermore, high growth rates and tolerance to wide variations in water quality make the crayfish species as an excellent for aquaculture [11]. The juveniles of the crayfish are very aggressive and display a strong competition for resources [6]. Besides, survival and growth were the biggest

problems that need to be solved for when reared juvenile of *C. quadricarinatus* especially for indoor culture. It is important to understand the effect of substrate for the performance of *C. quadricarinatus* because with the better understanding of types of substrate were not only improved the rearing technique, but it also helps in maximization of the utilization of space resulted in increase of the productions and also help in reducing the operational costs in aquaculture farming. Thus, the objectives were to determine the effect of different substrate for juvenile of *C. quadricarinatus* through the survival, the total number of moulting and growth rate.

II. Results and Discussion

Survival and weight gain of juvenile red claw, Cherax quadricarinatus

The result in treatment 2 (coral) has the highest survival in juvenile of *C. quadricarinatus* at the end of the study, while Treatment 1 (control) has the lowest number of C. *quadricarinatus* juvenile that left at 60 days of study (Figure 1). Figure 1 showed the different treatments against the survival (%) of juvenile for *C. quadricarinatus* under different treatments for 60 days. From the results, juvenile of *C. quadricarinatus* in treatment 2 (coral) has the highest survival rate with 81.25±8.84% and it displayed significantly ($P<0.05$) to other treatments.

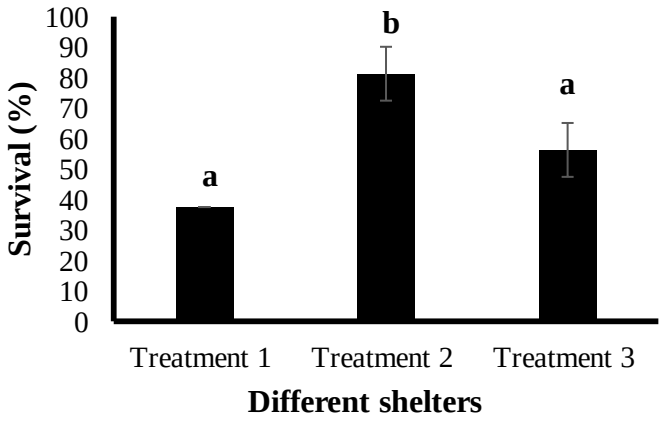

Figure 1: Survival in juvenile red claw, *Cherax quadricarinatus* after 60 days. Bars with different letters were significantly different ($p<0.05$) (mean ± S.D.)

In addition, juvenile of *C. quadricarinatus* in treatment 1 (control) showed the lowest survival rate with 37.50 ± 8.84 % and followed by treatment 3 (pipe) which is 56.25±8.84%. But, for treatment 1 and treatment 3 showed no significant ($P>0.05$) between it. Figure 2 showed the weight gain in juvenile of *C. quadricarinatus* after 60 days of experiment. Juvenile of *C. quadricarinatus* in treatment 2 (coral) demonstrated the highest of weight gain with 347.36±6.04% compared to others two treatments while the juvenile of *C. quadricarinatus* in treatment 1 (control) has the lowest weight gain with 122.60±20.51%.

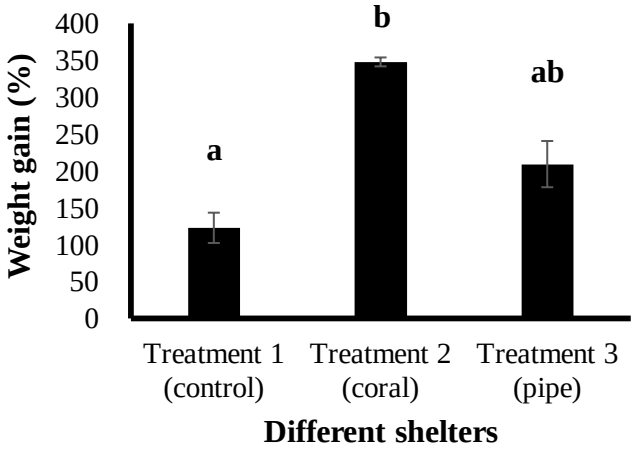

Figure 2: Weight gain in juvenile red claw, *Cherax quadricarinatus* after 60 days. Bars with different letters were significantly different ($p<0.05$) (mean ± S.D.)

The results for the shelter promote better growth and survival compared to control (no substrate) and this also makes a stronger influence on the provision of the srubstrate and the stocking density. Treatment 1 and 3 has a low in survival than treatment 2 because for treatment 1, *C. quadricarinatus* need a substrate in tank while treatment 3 has a pipe as a substrate and better than treatment 1. In the present study, the complexity of using substrate might provide hiding spaces for juvenile of *C. quadricarinatus* especially when molting and helped to prevent aggressiveness behaviour. This can be supported especially at juvenile stage, *C. quadricarinatus* is become more aggressiveness compared to the adult's stage that will attack their own species especially when space is limited, insufficient of feed and in molting stage [12]. Usually in the natural environment, *C. quadricarinatus* will find space to hiding hide under stone, lilypad and mud for hiding from the predator and also to reduce activeness among red claw [6].

Besides, with the provision of substrate were provided the surface areas in the tanks and increasing stocking density of *C. quadricarinatus* in the tanks. Yet, it will be less stress and activities that lead to less aggressiveness among *C. quadricarinatus*. Furthermore, the provision of artificial substrate were increased the habitat complexity with the improvement of survival and production in community cultured in *C. quadricarinatus* [13]. Since *C. quadricarinatus* were cultured in clear water, they needs to use the shelter to hide from direct sunlight. These happen due to *C. quadricarinatus* are nocturnal species that active in late evening and

oppositely they will not active in the morning and will find place to hide in natural environment [5]. By using the coral and pipe as shelter showed the coral gives the higher growth and survival compared to the pipe. In the present study, the coral structures are quite similar to the natural habitat that makes the C. *quadricarinatus* comfortable and easy to hide due to the physical appearance of coral that has many holes to hide. This coral structure is more look alike to rocks compared pipe and *C. quadricarinatus* were more adapted live in coral than the pipe. From the previous study showed the using gravel-lined as a substrate in the pond improves the growth of *C. quadricarinatus* and water quality in the pond [14]. In the present study, the algae or materials attached to the surface coral will be eaten by red claw. Stachowicz and Hay [15] showed the materials and attaching for dead coral are act as extra food on crabs and these algae can help in do photosynthesis that gives a result in growing faster in coral

Specific growth rates, carapace length and total number of molting in juvenile red claw, Cherax quadricarinatus

Figure 3, figure 4 and figure 5 showed the specific growth rates, carapace length and total moulting in juvenile of *C quadricarinatus* after 60 days. Juvenile of *C.quadricarinatus* in treatment 2 (coral) has the highest specific growth rate with 2.50±0.02 % per day. Moreover, it showed the significantly different (P<0.05) higher to all other treatments. For the juvenile of *C.quadricarinatus* in treatment 1 (control) exhibit the lowest specific growth rate with 1.33±0.15 % per day and followed by treatment 3 which is 1.88±0.17%. Hence, there are no significant different (P>0.05) between treatment 1 (control) and treatment 3 (pipe). For the carapace length, treatment 2 (coral) has the highest in carapace length with 32.93± 0.93% and treatment 1 (control) has the lowest in carapace length with 25.84± 0.33%. There was the significantly different (P<0.05) compared to other treatments. For molting, treatment 2 (coral) also has the highest with 55.00±2.93%. Additionally, in treatment 3 (pipe) and treatment 2 (coral) has no significance difference (P>0.05) each other and it showed that treatment 1 (control) has the lowest in total number of molting with 29.00±0.71%.

In the present study, the total number of molting in juvenile for *C. quadricarinatus* affected when the presence shelter in the tank. Contrast with the total number of molting in control showed the lowest number in moulting because the juvenile of *C. quadricarinatus* was moulted when they found the place to hide. Treatment 2 (coral) has the highest for total number of molting compared to treatment 3 (pipe) because treatment 2 (coral) has complexity and its feels look alike their own natural environment compared to treatment 3.

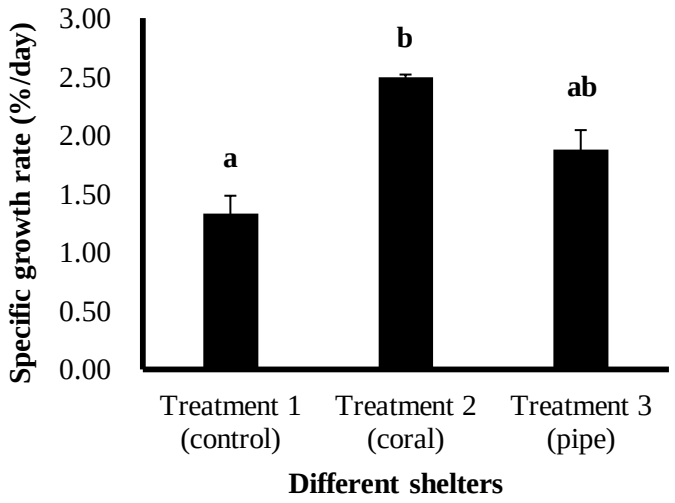

Figure 3: Specific growth rates in juvenile red claw, *Cherax quadricarinatus* after 60 days. Bars with different letters were significantly different (p<0.05) (mean ± S.D.)

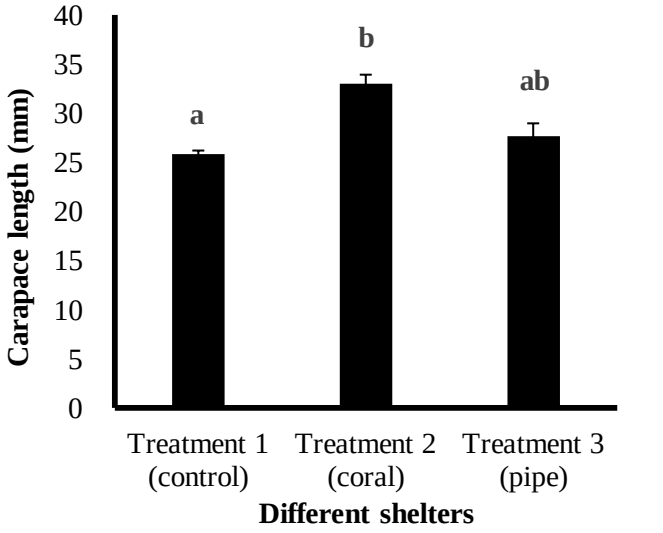

Figure 4: Carapace length in red claw, *Cherax quadricarinatus* after 60 days. Bars with different letters were significantly different (p<0.05) (mean ± S.D.)

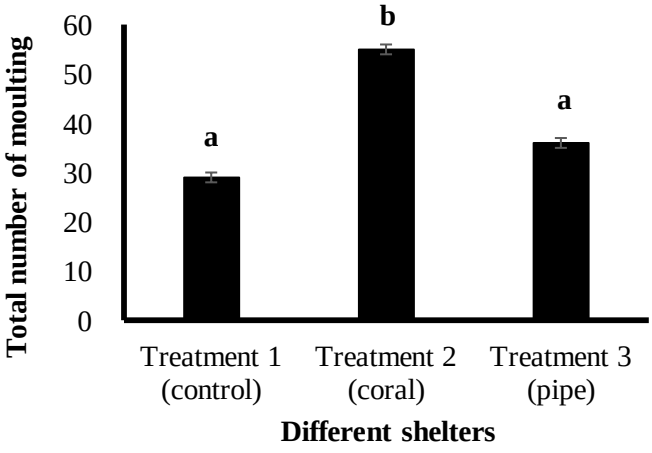

Figure 5: Total number of moulting in juvenile red claw, *Cherax quadricarinatus* after 60 days. Bars with different letters were significantly different (p<0.05) (mean ± S.D.)

Since the natural habitat of *C. quadricarinatus* are usually in the area with the stone, thus the coral are more like a stone compared to pipe.From the previous study, mutualism between coral and invertebrates make a positive interaction that coral provides crabs with dietary supplement and shelter from predation [15]. Based on Richards [16], the coral has a mineral contains which is calcium bicarbonate. This calcium will help the *C. quadricarinatus* for moulting and when *C. quadricarinatus* red claw moulting, the shell is soft at this time and the other *C. quadricarinatus* or predator want to try to eat. At this time, the calcium inside the coral was functioning to help for the shell of *C. quadricarinatus* to harden back to the normal with reabsorb the mineral from the old exoskeleton and coral. Besides, the use of corals in treatment may contribute to the high concentration of calcium in the water which is essential for invertebrate growth and survival.

III. Conclusion

As a conclusion, it is possible to introduce the usage of substrate for the culture in juvenile of *C. quadricarinatus* because using the substrate were effective towards the survival and growth in juvenile of *C. quadricarinatus*, particularly for using coral as a substrate. Additionally, the coral was given the best on the growth, survival and molting in juvenile of *C. quadricarinatus* compared to others. Thus, the growth, survival and molting of *C.quadricarinatus* were increased using the suitable substrate. Besides, the coral also used as an ornamental when cultured the *C quadricarinatus* in tanks but subjected to the permission of the fishery department. For recommendation, the coral as the substrate would be first proposed for its beneficial utilization compared to other substrate. However, the design in the present study only limited to small-scale in culturing of *C. quadricarinatus*. In the big scale culturing, the modification is flexible especially on the size of substrate that suitable the space of culture. Yet, the alteration in the terms of different size, species and colour can be considered for the further studies purpose. Nevertheless, due to limited of *C. quadricarinatus* that can be found, further study can be done by comparing this coral with other substrate and can also be tested with other species. In addition, for future experiment, experiment will do with more samples of *C. quadricarinatus* with three replicates for each treatment and with varieties of substrate such as rocks and others.

IV. Materials & Methods

Tank preparation and experimental design

This experiment was set at Shrimp Hatchery, Borneo Marine Research Institute (BMRI) with six rectangular fibre tanks and the size of each tank was 85 L. Every tank was equipped with aeration to maintain the dissolved oxygen to the tanks. There were three different treatments which are treatment 1 (control), treatment 2 (coral) and treatment 3 (PVC pipe) (Figure 6). The tank for each treatment was in duplicate and randomly arranged. Black nets were installed on top of each tank for circumventing foreign objects entering the tank and to protect them from direct sunlight. The juvenile of *C. quadricarinatus* was obtained from Aquaponic and Integrated Multi-trophic Aquaculture (IMTA) area of Borneo Marine Research Institute (BMRI), UMS and were acclimatized for 7 days before started the experiment. The juvenile of C. *quadricarinatus* for each tank was 8 tails for each treatment tank with the range of size about 2.54 to 5.10 cm. Additionally, a storage black tank (800 L) was set up and filled with tap water for stocking water of the experiment.

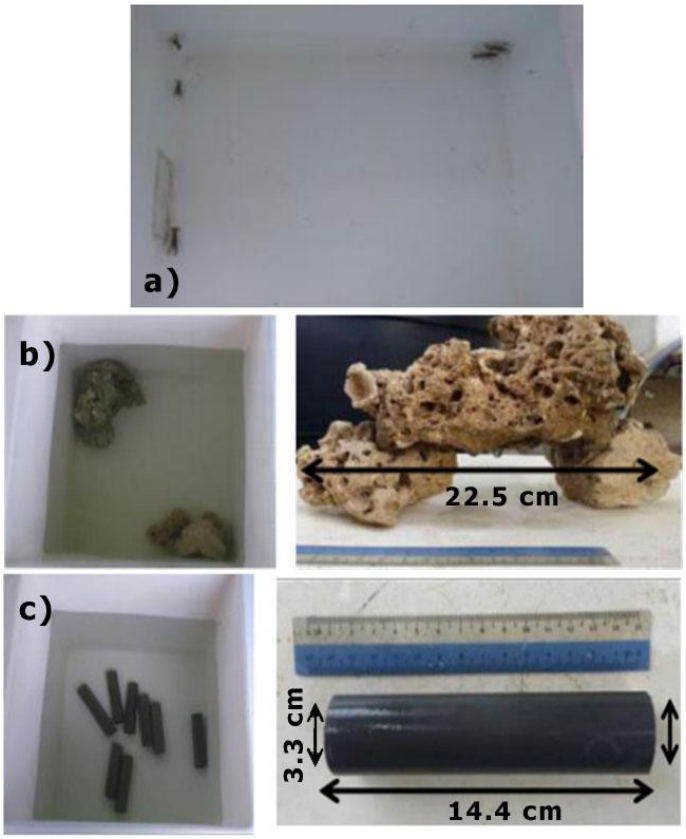

Figure 6: Three different treatments; **a)** Treatment 1 (control), **b)** Treatment 2 (with coral) and **c)** Treatment 3 (with pipes).

Diet and feeding rate

The juvenile of *C. quadricarinatus* were fed with the commercial marine shrimp diet (Royal Dragon Vannamei Prawn Feed) with crude protein and crude lipid for twice a day in the morning (8 am) and in evening (4 pm). This red claw was fed for 5% of total body weight.

Water quality

The water quality such as dissolved oxygen (DO), temperature and pH were monitored twice a day which in the morning (8 am) and in evening (4 pm) with the YSI Professional Plus Multiparameter Water Quality Instrument at Shrimp Hatchery, Universiti Malaysia Sabah. For every two days, the tanks were siphoned with 20 % of water in the tanks.

Growth performance and survival

The total lengths of juvenile for *C.quadricarinatus* were measured using vernier callipers (non-digital Vernier callipers). While for the body weight were weighted by using electronic balance weight. The total length, body weight and the survival rate were also measured along 60 days of the experiment. The measurement was done in 10 days interval. The specific growth rate (%/day), weight gain (%), survival (%) and carapace length (Mona *et al.*, 2015) were measured using the following formulas;

$$\text{Weight gain (\%)} = \frac{Final\ body\ weight\ (g) - Initial\ body\ weight(g)}{Initial\ body\ weight\ (g)}\ x100\ \%$$

$$\text{Specific growth rate (\%/day)} = \big(In(Final\ weight\ in\ grams) - In(Initial\ weight\ in\ grams)\big)x100\ /t\ (in\ days)$$

$$\text{Survival (\%)} = \left(\frac{Final\ no.f\ red\ claw}{Initial\ no.of\ red\ claw}\right)x100\ \%$$

Total number of molting

The evaluation of the total number of molting was done by calculating the total of moulting in each replication that recorded for 60 days during the experiment.

Statistical analysis

For this experiment, the effects of shelter towards the survival, moulting and growth on juvenile of *C. quadricarinatus* were analysed by SYSTAT (Statistical and Statistical Graphics Software Package) with version 13.2. Kruskall Wallis test were used to determine if there are statistical difference among treatments. Conover-Inman test was applied to detect significant difference between means ($P< 0.05$).

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