Preliminary study on the growth development of blood cockle (*Tegillarca granosa*) by using different substrates in the hatchery system

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Abstract

Culturing of bivalves in the hatchery is the most popular technique for aquaculture that promotes a healthy bivalve's production, where the animal would be less exposed to pollution from human activities. The increase of industrial and agricultural waste along the coastal region has altered the environment, hence affecting the growth and survival of aquatic organisms, particularly clams which is one of the sources of protein to coastal communities. Due to the high demand for blood cockles and drastic change in term of production from culture site, the price of blood cockle per kilogram has increased. Thus, this study aimed to observe the growth development of blood cockles (*Tegillarca granosa*) using different substrates in a hatchery system. In this study, adult cockle from Kuala Juru, Penang on the northern Straits of Malacca were collected from wild and maintained in hatchery system at Centre for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia (USM). 50 individuals of adult cockle were used for each treatment. The growth characteristics, such as weight, length, thickness, and height of the cockle samples were monitored in both sand and mud substrate experiment tanks until the end of their survival. Generally, both substrates showed an increment in the growth characteristics from initial measurement. Increase in growth characteristics of cockle samples in the sandy experimental tank were, 3.919±0.717 g in weight, 22.90±1.72 mm in length, 15.30±1.69 mm in thickness and 17.40±1.87 mm in height at the end the experiment. Meanwhile, cockle's culture in mud substrate showed growth of an average weight of 7.410±2.022 g, 27.40±2.98 mm in length, 17.60±1.94 mm in thickness and 20.60±2.06 mm in height. Furthermore, cockle samples in sandy substrate particularly showed a higher survivability of up to 4 months, compared to mud that only survived for two months. Therefore, this preliminary study suggest that blood cockle could be cultured using a sand type substrate as an alternative to mud in the hatchery system.

Keywords: Blood cockle culture, *Tegillarca granosa*, Hatchery, Growth development, Substrate

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Introduction

The blood cockle (*Tegillarca granosa*) is a commercially important shellfish and dominating 93% of total shellfish species production in Malaysia (DOF, 2013). They have been distributed worldwide and cultured for human consumption in China, Japan, Taiwan, Thailand and Malaysia (DOF, 2015). In Asian countries, the culture areas for cockles are found mainly in mangrove areas where it has a soft muddy substrate. The mudflat areas were highly preferred as the water bodies are enriched with the phytoplankton, a good source of food for cockles (Pathansali and Soong, 1958). Among the Southeast Asian countries, Malaysia becomes the largest producer of adult cockles and a major exporter of spats to Thailand (DOF, 2011). Selangor and Perak state in the west coast of Peninsular Malaysia are the most popular districts for the natural spat production throughout the year. This is due to the optimum condition of the culture bed, which suitable for natural spawning of spat and growing of adult cockle (Mirzaei *et al.*, 2017). The statistical data from Department of Fisheries (DOF) showed a fluctuation in the production of cockles farming from year 1990 until 2017 (Fig. 1).

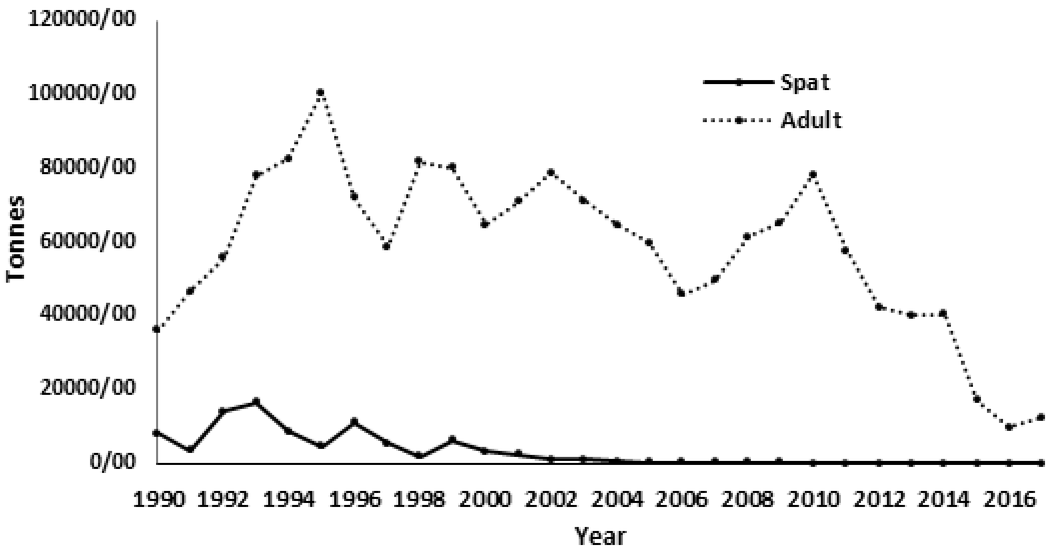

Figure 1: Production of spat and adult cockles in Malaysia from 1990 until 2017 (Source: Department of Fisheries report 1990 -2017).

A decline in cockle production were observed in the year 2011 and this trend continued until 2017. The total yield for the year 2015 was only 16, 866.33 tonnes compared to 57, 544.40 tonnes in 2011, a reduction of 71% (DOF, 2017). In the past, cockles were still considered as one of the cheapest shellfish, but due to current high demand and low supply, the price of cockles per kilogram has increased exponentially. This issue caught the

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attention of many agencies to determine the underlying cause in the reduction of cockle production at the culture sites. Several factors were leading to their high mortality rate such as environmental issues, low food availability in culture areas, smuggling, and overharvesting activities. Commonly, the culture sites are located in open areas where these areas were exposed to many pollutants from a point and non-point source (Buck *et al*., 2004). Besides, the culture sites were also exposed to predators and parasites, a significant problem for all types of aquaculture (Nair, 1999).

The characteristic of the substrate is very important in the culture area of blood cockles as it is the source of food, habitat, refuge, and nursery ground. Sediment nutrients can also be used to determine the survival rate and growth development of cockle culture by monthly monitoring (Jintana *et al.,* 2015). Normally, the naturally cultured cockles depend on the food availability in the substrate and water column. Therefore, the nutrients of the substrate are very important to determine the soil fertility. However, the long term culture in the same area may lead to soil infertility that leads to high mortality in which disturbing the growth development of cockles in culture site. Thus, this study focused on the hatchery cultivation of blood cockles by using different substrates to observe their growth development.

Material and methods

Sample collection and experimental set up

The broodstock sample of blood cockles with the size range of 20 mm until 30 mm were collected from Kuala Juru, Penang and transported to the hatchery in Centre for Marine and Coastal Studies (CEMACS), Universiti Sains Malaysia (USM). Along with the cockle collection, mud samples were also collected. The cockles were left to acclimatize for three days before placing it into the experiment tanks. 50 individuals of adult cockle were exposed in each different substrate which was sand with a size range of 1.00 to 2.36 mm and mud with a size range of 1.4 to 78.0 µm. The cockles were fed twice daily with phytoplankton, *Chaetoceros calcitrans*, with cell density 1.56 x 10^6 cells/mL, which is the most commonly used algae in aquaculture and easily grown in outdoor culture (Bruce *et al*., 1940). The cockles were maintained in the open system with natural seawater after the feeding period.

Growth measurement

The growth characteristics of all the cockle samples were measured prior to the experiment and also once a week to monitor their growth development. The growth characteristics that were measured comprise of weight, length, thickness, and height of the cockle sample also the mortality of the cockle was observed every day.

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Water quality measurement

Physicochemical parameters such as temperature, salinity, pH, and dissolved oxygen (DO) of the seawater in each experimental tank were measured every day by using YSI Proffesional Plus (YSI Inc®) multiparameter probe.

Statistical analysis

Statistical analysis was performed by using IBM SPSS Version 26. One-way ANOVA was applied to identify the significant difference between growth characteristics such as weight, length, thickness, and height of cockles in different substrates.

Result and discussion

In general, the physicochemical parameters measurements were slightly unstable for certain days. The readings obtained are presented in (Table 1).

Table 1: Mean values with standard variation of physicochemical parameters of seawater in the experiment tanks.

Parameter	Result (N = 80)	
	Mud	Sand
Temperature (°C)	29.07 ± 0.75	29.20 ± 0.76
Salinity (ppt)	30.09 ± 0.38	30.77 ± 0.78
pH	7.40 ± 0.14	7.86 ± 0.18
Dissolved oxygen (mg/L)	4.64 ± 0.34	5.56 ± 0.37

Based on the results, the average DO concentration in sand was 5.56±0.37 mg/L while in mud 4.64 ± 0.34 mg/L. This showed that the concentration of DO in mud lower compared in sand. This was suggested due to the consuming of microorganisms to decompose the organic materials that use up the oxygen (Jintana *et al.*, 2015). Besides, the study conducted by Jalal *et al*. (2009) at Pahang estuary showed that the optimum range of DO for cockle survivability was between 6.8 mg/L until 7.50 mg/L. Seekaew *et al*. (2011) has mentioned that pH in the aquatic environment plays an important role it influences the growth of benthic organism and control the breakdown for the element of phosphorus and nitrogen that affects the producing of phytoplankton in the water. The pH values in the experiment tanks were 7.40 (mud) and 7.86 (sand) respectively. Schade *et al*. (2016) study further confirms that the low mortality rate of cockles from the Baltic sea with a pH of 7.4 until 7.8 which being the ambient pH of seawater. Thus, the pH of water is important because it affects the activities of a marine organism. The water temperature in mud was 29.07±0.75 °C and in the sand 29.20±0.76 °C. The average salinity in mud was 30.09±0.38 ppt while in sand 30.77±0.78 ppt. normally the culture area of cockles with salinity range of 26 until 31 ppt (Yurimoto *et al.,* 2014). This result considered as a standard range of salinity. The growth characteristics of blood cockles in sand and mud type of substrates were presented in Figure 2.

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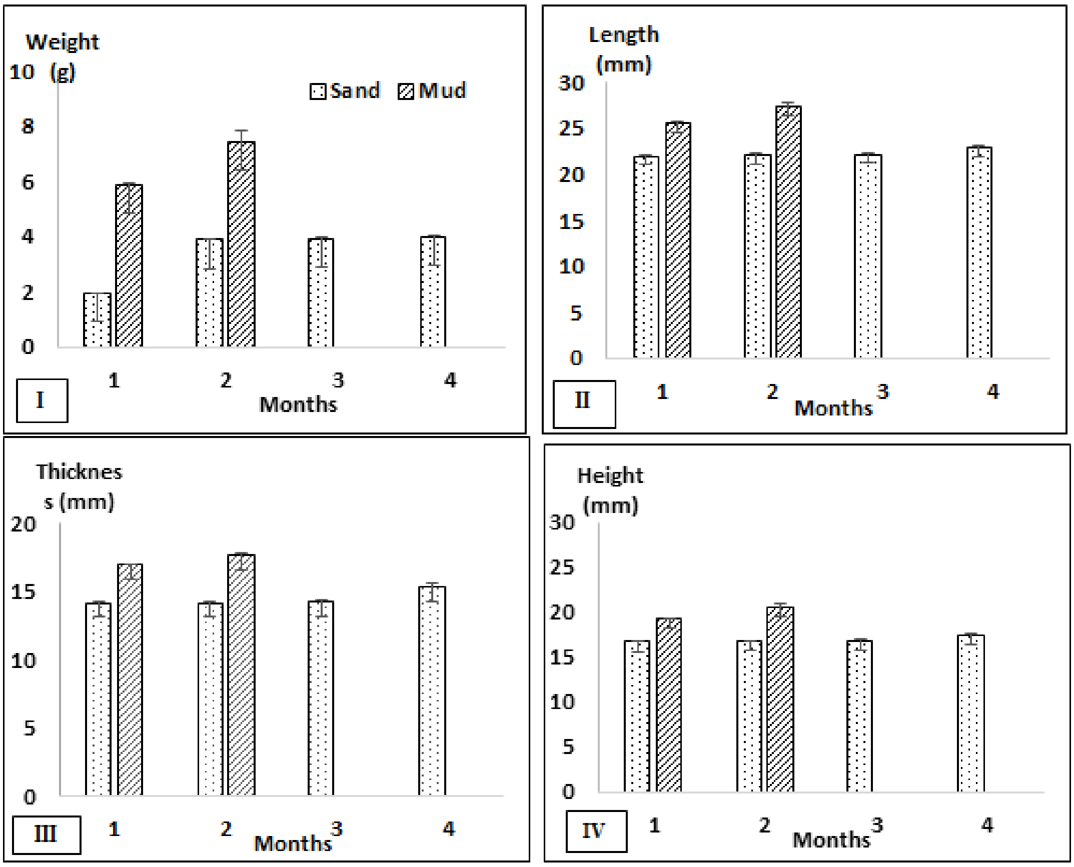

Figure 2: Growth development of blood cockles within 4 months in the hatchery by using mud and sand type substrate. I) Weight (g) II) Length (mm) III) Thickness (mm). IV) Height (mm). The data showed a significant level of 95% where F= 3.907, *p*-value = 0.01(length), F= 156.291, *p*-value = 0.00 (weight), F= 10.551, *p*-value =0.00 (thickness), and F=3.589, *p*-value = 0.15 (height) in sand, F=29.078, *p*-value = 0.00 (length), F= 16.873, *p*-value = 0.00 (weight), F= 6.085, *p*-value= 0.02 (thickness), F= 20.336, *p*-value= 0.00 (height) in mud.

Based on Figure 2, the results showed an increment in the growth of blood cockles in terms of weight, length, thickness and height in both sand and mud experimental tanks. One-way ANOVA reveals that there was a significant difference ($p<0.05$) in the growth increment of cockles in the sand and mud substrate. The initial average growth characteristics for both substrates in weight, length, thickness, and height were 1.921±0.246 g, 22.04±0.98 mm, 14.11±0.87 mm and 16.66±0.88 mm in the sand while in mud, 5.820±0.533 g, 25.60±0.89 mm, 16.90±0.66 mm and 19.20±0.69 mm respectively. The blood cockle samples in the sand substrate showed an increment by 34% in weight, 3.9% in length, 4.2 % in thickness, and 8.43% in height over four months. Similarly, in mud substrate, an increase was observed in weight, length, thickness and height by 27.3%, 7%, 1.4% and 4.14% respectively within 2 months. A study from Amirul *et al*. (2019) showed the average increment of cockle growth witihin Kongkong Laut estuaries in

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Johor was 2.70 mm per month under 5 months observation. This shows a difference in terms of growth performance between hatchery and the natural sites. However, culturing blood cockles in the hatchery can be alternative method to support the low production from the natural cultural sites. In terms of survival, the cockles survived longer in sand compared to mud. The increment of growth characteristics of blood cockles in this study also related to the frequency of feeding of *Chaetoceros calcitrans* which were given twice daily. Piyapong (2011) stated that *Chaetoceros calcitrans* comprised of nutritional value for marine filter feeders that widely used in aquaculture especially in commercially important shellfish industries.

Based on the visual observation, the estuary system at the natural culture site was highly exposed to industrial pollutant from the factories around Perai area. The mud samples were collected were grey-black coloured. Study conducted by Yap and Tan (2008) at Kuala Juru, Penang proves that the grey-black coloured mud is an indication of high industrial effluents. This may be a big problem for natural cockle culture sites as the mud contains high level of hydrogen sulfide and other harmful heavy metals. Hydrogen sulfide is produced during the decomposition of organic matter. It is also known that mud substrate has higher tendency to absorb hydrogen sulphide than sand (Dugdale *et al.,* 1977). Hydrogen sulphide produces a metal sulfide in which leads to toxicity towards bivalves in the aquatic environment. A few studies showed that a high concentration of sulfide could affect the respiratory and cause metabolic depression in cockle (Meksumpum, 2005). Yurimoto *et al*. (2014) had proved the cockles very sensitive towards the low food availability and high heavy metal in the aquatic environment. Hence, this factor will lead to high mortality of cockles in natural environment. Therefore, the hatchery system could play an important role for the sustainable production of cockles in near future.

Conclusion

The growth development of cockles in both sand and mud substrates showed an increment of growth characteristics such as weight, length, thickness and height. However, the overall results revealed the highest survival of cockles was in the sand substrate. Since this would be a preliminary result, more in depth investigation will be done on the nutrient concentration of the substrate and the food availability that may affect the growth characteristic of cockles. Thus, the culturing of blood cockles in the hatchery could be one way to produce a healthy cockle in which the condition is less exposed to any source of pollution compared to natural culture sites.

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