Growth performance of Asian clam (*Corbicula fluminea*) in a semi-closed system

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Abstract. In the present study, an Asian clam (*Corbicula fluminea*) semi closed growth out system was developed in order to monitor the growth performance of the clam. The system is comprised of a glass aquarium equipped with a sponge filter system and water pump. In the depuration system, there is one container with 40 Asian clams used for the study. The growth performance of the clams was monitored based on a weekly basis for 4 consecutive weeks. Each container was filled with 10 cm of sand as substrate. There were 2 treatments, namely the control treatment, and the fermented soy pulp (FSP) treatment, where 1% FSP was mixed homogenously with the sand to serve as feed for the clams. Each treatment was made in triplicates. The findings of the present study showed that the Asian clam from the FSP treatment group showed a significantly higher weight gain (3.73±1.67%) ($p<0.05$) compared to the control treatment group (−0.35±0.65%). In contrast, Asian clam from the control treatment group performed better in term of survival rate, where the recorded result was significantly higher (75.83±7.22%) ($p<0.05$) compared to the Asian clam from the FSP treatment group (67.5±0.00%). The findings of the present study were some of the first to be reported in the literature concerning the growth performance of Asian clams in a semi-closed system.
Key Words: aquaculture, bivalve, nutrition.

Introduction. Asian clam (*Corbicula fluminea*), is a species of freshwater clam which can be found throughout the world. This species of clam is native to Asia, Africa, and Australia (McMahon 2000). Recently, many scientific reports have claimed that the clam population has dispersed into other countries, where they are not indigenous, like European countries and the United States of America (Cox 2004). It is hypothesized that the dispersion had transpired through the means of aquaculture, transportation, and global trade (Cox 2004). In consequence, the event has given rise to a great threat against the native clam species of European countries and USA (Cox 2004). With high prolificacy, rapid growth, and short life span, the Asian clam is naturally equipped to be an excellent invasive species. European and American scientists are exploring possible counter measures to inhibit the population boom of Asian clams in their respective countries in order to conserve the native clam and bivalve populations of their freshwater aquatic ecosystems (Cox 2004).

In the Asian region, *C. fluminea* was also reported in Japanese waters and, subsequently, researchers have officially declared the clam as an invasive species (Okawa et al 2016). Nevertheless, based on the rich nutrition profile of the Asian clam, Japanese are actively harvesting and processing the clams into commercial human health supplements. Meanwhile, in China, Asian clams are believed to possess excellent nutritional properties and medicinal values (Zhu et al 2018). However, the population of this small bivalve was reported to be declining in China, especially in Hongze Lake (Zhu et al 2018). The scientists of China are planning to carry out artificial breeding meant to maintain the population of the clam in the lake (Zhu et al 2018). Asian clam, or alternatively known as the prosperity clam or golden clam due to its golden color, possess viable economic value and the potential to be one of the most important aquaculture species on the account of its excellent nutrient profile and medicinal properties.

In Malaysia, Asian clams are commonly harvested from the wild and processed into smoked Asian clams. Smoked Asian clam is a Kelantanese traditional snack and it is popular among people (Lee et al 2018). The market demand for Asian clams in Kelantan was estimated 300 metric tonnes per month with the market value of USD 700000. The main sources of Asian clam for the Kelantanese market are mainly from Pergau Lake, rivers, streams, and other water bodies in Kelantan. However, recently, Pergau Lake has been declared a state park, where all fishery activities are currently prohibited, including the harvesting activity of Asian clams. In effect, local Asian clam harvesters were left without options and, in turn, they needed to look and explore new sources of wild Asian clams that are sufficient to fulfill the huge market demand in Kelantan. To date, the main source of Asian clams for the Kelantanese market is the import from Thailand. The demand of Asian clams is expected to surge in the near future. Furthermore, smoked Asian clam has been recognized as a Kelantanese heritage snack, which will consequently boost the market demand and price.

There is a huge demand of Asian clams from Kelantan, and the clams harvested and supplied from local sources cannot meet the market demand. This has subsequently lead to the scarcity of Asian clam, causing their wholesale and retail price to increase yearly. Correspondingly, Asian clams are recently imported from Thailand to be distributed around Kelantan in order to fill the supply gap. With the population of wild Asian clams declining at an alarming rate due to over-exploitation, Asian clam commercial farming will certainly be inevitable in the near future. There is a necessity to have commercial Asian clam farming as soon as possible to cope with the rapid growth demand of the clam on the market. Hence, the aim of the present study is to present a growth system of Asian clams in a semi-closed system.

Material and Method

Asian clam growth system. The experiment was carried out in the Aquaculture Laboratory of the Malaysia Kelantan University in September 2018. In the present study, 6 glass aquariums with the size of 122×46x46 cm were used. 2 treatments were used, namely control and fermented soy pulp (FSP), where triplicates were made for each treatment. Each aquarium contained two smaller containers with the size of 50×36×5 cm, and were filled with 2 cm of sand (sand 99.4%; silt 0.44%; clay 0.15%) (Smith et al 2018). The aquariums were equipped with a sponge filter system and water pump. For the control treatment, the sand sediment was used as bedding without any alteration, while for the second treatment, the sand was mixed with 1% FSP (Prima Mekar, Malaysia). The FSP was already in powder form, and could be directly mixed with the sand sediment. The water pump equipped in the growth out system was run non-stop for 3 weeks before introducing the experimental clams, in order to stabilize the environment beforehand. On the first day of the fourth week, Asian clams were introduced into the system.

Growth performance of Asian clam. 40 Asian clams were placed on the sand bedding for each replicate in order to monitor the growth rate of their length, width, weight, as well as their survival rate. The weight, length, and width of clams were recorded as data for Week 0 (initial data). Each aquarium was already equipped with a span filter system and a water pump to recycle the water before introducing the clams, and their usage was continued as usual. The growth and survival rate of the clams were monitored for 4 weeks. The total length and width of all clams were measured weekly by using a digital caliper (Mitutoyo, Japan) and the weight was observed by using analytical balance (Shimadzu, Japan). The water temperature, dissolved oxygen (DO), and potential hydrogen (pH) of all experimental aquariums were monitored on a weekly basis by using a multi parameter (YSI, USA), whereas total ammonia in the experimental aquarium was calculated and recorded by using a spectrophotometer (Hach, Germany). Water exchange was carried out once a week to replace about 50% of the total water volume in the aquarium. The calculation for the growth rate of weight is the following (Lee et al 2017; Lee & Wendy 2017; Lee et al 2018):

$$\frac{(\text{Final Weight} - \text{Initial Weight}) \times 100\ \%}{\text{Initial Weight}}$$

The equation used for determining the growth rate of width is the following (Lee et al 2018):

$$\frac{(\text{Final Width} - \text{Initial Width}) \times 100\ \%}{\text{Initial Width}}$$

The equation used for determining the growth rate of the length is the following (Lee et al 2018):

$$\frac{(\text{Final Length} - \text{Initial Length}) \times 100\ \%}{\text{Initial Length}}$$

The equation used for the survival rate of Asian clam is the following (Lee et al 2018):

$$\frac{(\text{Initial total number of clam} - \text{Total number of dead clam}) \times 100\ \%}{\text{Initial total number of clam}}$$

Statistical analysis. The total weight gain, length gain, width gain and survival rate of Asian clams from control and FSP were compared. T-test was used to determine differences ($p<0.05$). The statistical analysis was conducted using SPSS software version 23.

Results and Discussion. In the present study, the overall growth performance of Asian clams from the control treatment was revealed to be superior compared to that of Asian clams from the FSP treatment in terms of length and width, but the result is not significant ($p>0.05$) (Table 1). The growth rate of length of Asian clams from the control group was 6.58±1.1%, while the growth rate of width was 11.1±4.47%. The growth rate of length and width of Asian clams from the FSP treatment group were 5.17±3.58% and 9.18±2.3%, respectively.

Asian clams from the FSP treatment had a significantly higher growth rate of weight (3.73±1.67%) when compared to the control group (−0.35±0.65%). However, Asian clams from the control treatment performed significantly better in terms of survival rate, with 75.83±7.22%) ($p<0.05$) compared to Asian clams from the FSP group (67.5± 0.00%) (Figure 1).

The water parameter values of the experimental tanks are presented in Table 2. During the experiment, the overall value of DO ranged from 6 to 7 ppm, whereas the overall ammonia (NH_3) value ranged from 0.05 to 0.1 ppm. The overall pH value was recorded between 6.3 to 7.3.

Table 1

Growth performance of Asian clam (*Corbicula fluminea*)

Treatment	*Length growth rate %*	*Width growth rate %*	*Weight growth rate %*	*Survival rate %*
Fermented soy pulp treatment	5.17±3.58	9.18±2.3	3.73±1.67*	67.5±0.00*
Control treatment	6.58±1.10	11.1±4.47	−0.35±0.65*	75.83±7.22*

Note: * - significant difference at p<0.05.

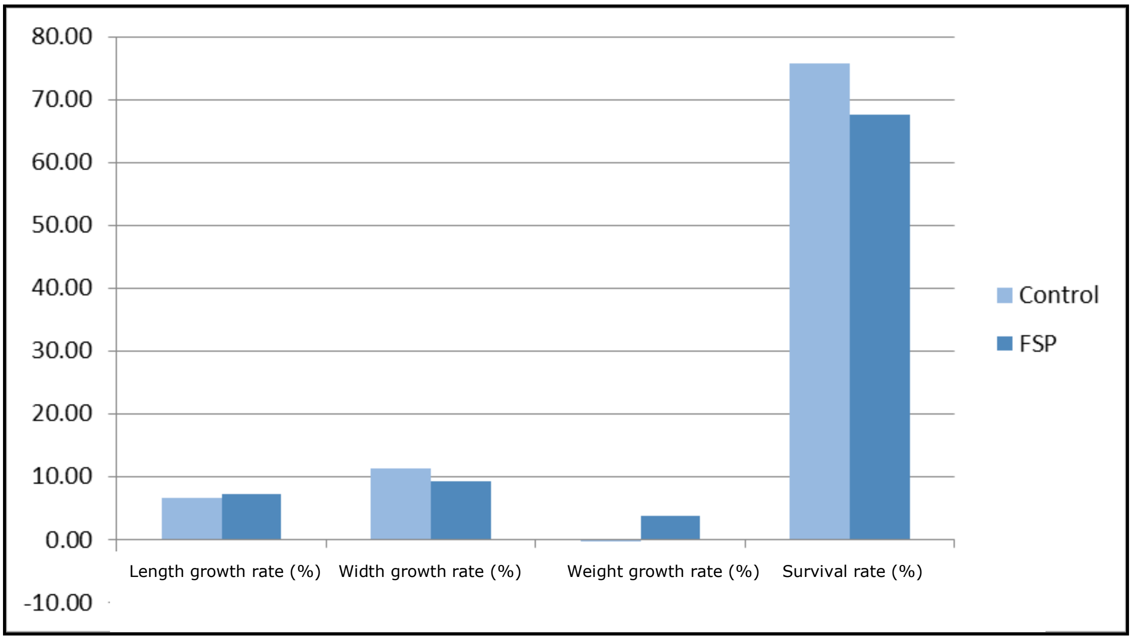

Figure 1. Growth performance (%) of Asian clam (*Corbicula fluminea*); FSP - fermented soy pulp.

Cherry et al (2005) found that Asian clams at high stocking density (10000 clam m^{-2}), at a recorded ammonia concentration of 5.03 ppm at 26.0ºC could greatly reduce the DO level in the static water system, and correspondingly lead to high mortality rates. However, in the present study, the stocking density of the clams is not an issue that could have affected the survival rate of the clams.

Another factor that may had influenced the growth rate of Asian clams is water temperature. Welch & Joy (1984) reported that the length growth rate of the Asian clam was more than 10 times higher, while the weight growth rate was more than 20 times higher in the summer season, at a temperature of 26.6ºC, compared to the growth rate in winter, at 10.3ºC. A temperature lower than the optimum will not only slow down the growth rate of bivalves, but would also prevent spawning (De Abreu Correa et al 2012). In the present study, all of the mentioned water parameters were in the optimum range.

The initial length of Asian clams would also influence the growth rate of the clams. Generally, an Asian clam with the size of 20 mm and higher has a slower growth rate compared to a clam with the size of less than 20 mm (Welch & Joy 1984). Throughout the present study, the selected sizes of Asian clams were ranging from 13 to 19 mm, with only a single overlooked individual with 21 mm. Hence, the size of clams in the present study was scientifically categorized within the same development phase described by Welch & Joy (1984).

The availability of food in the Asian clam farming system must not be neglected. For example, Serdar (2018) established a strong correlation of the presence of feed, which was suspended particulate organic matter (SPOM) and microalgae, with the growth rate of the studied Asian clams. In the present study, FSP was used as feed for the experimental Asian clams, trying a new feed application in such manner for the species. The overall growth rate of Asian clams in the treatment group supplied with FSP was significantly higher compared to that of Asian clams from the control group.

Conclusions. The developed depuration system did not merely purify the flesh of Asian clams, but also contributed toward their weight performance. However, further studies need to be carried out for enhancing the water quality of the treatment system when supplied with FSP, in order to improve the survival rate of clams.

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Conflict of Interest. The authors declare that there is no conflict of interest.

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