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The Effect of Fermented Soy Pulp on The Growth of Asian Clam, *Corbicula fluminea*

By

Farizah Binti Abdul Ghafar

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DECLARATION

I hereby declare that the work embodied in here is the result of my own research except for the excerpt as cited in the references.

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Supervisor Signature

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The Effect of Fermented Soy Pulp On The of Growth of Asian Clam (*Corbicula fluminea*)

ABSTRACT

Asian clam is one of the snacks that is favored by the Malaysian especially the one from the east region of the Peninsular of Malaysia which are Kelantan, Terengganu and Pahang. Asian clam is the one of the bivalve mollusk species from the Cyniridae family. Then, fermented soy pulp(FSP) is the by- product of the soy industry since the industry only need the milk while the residue will be throw away however the fermented soy pulp has high content of protein hence it is suitable to be used as the animal feed. The study was aimed to examine the growth performance of the Asian clam (*Corbicula fluminea*) by using the fermented soy pulp as the feed source. In this study, the weight, height and length of the Asian clam were the parameter that has been recorded. All of the sample of Asian clam were farmed in the semi closed system for five week periods. 120 samples of Asian clam were used in this research and it were divided into two treatments. As a result, the best percentages (%) for the mean of weight, height and length increment from FSP treatment are 1.63 ± 0.34, 1.43 ± 0.13 and 1.57 ± 0.14 respectively. For the control treatment, the best percentages (%) of weight, height and length increment are 1.60 ± 0.33, 1.37 ± 0.15 and 1.60 ± 0.34 respectively. The finding of this result shown fermented soy pulp can be used as feed source of Asian clam

Keywords: *Corbicula fluminea*, fermented soy pulp, byproduct

Kesan Tapai Hampas Soya Terhadap Kadar Pertumbuhan Etak (Corbicula fluminea)

ABSTRAK

Etak merupakan salah satu makanan ringan yang digemari rakyat Malaysia terutama yang berasal dari kawasan Pantai Timur Semenanjung Malaysia iaitu Kelantan, Terengganu dan Pahang. Etak merupakan salah satu bivalve daripada spesis moluska yang berasal daripada keluarga Cyniridae. Hampas kacang soya yang telah diperam ialah produk hasil lain daripada industri susu kacang soya yang mana merupakan bahan buangan dari industri kerana industri hanya memerlukan susu. Hampas kacang soya yang telah ditapai (FSP) mempunyai nilai protein yang tinggi jadi ia sesuai dijadikan makan tambahan. Kajian ini bertujuan untuk memeriksa kadar pertumbuhan etak (*Corbicula fluminea*) dengan menggunakan hampas kacang soya yang telah ditapai sebagai sumber makanan. Dalm kajian ini, sebanyak 120 sampel etak digunakan untuk melihat kadar tumbesarannya dan dibahagi kepada dua rawatan. Hasil daripada kajian ini menunjukkan, peratus terbaik untuk purata berat, tinggi dan panjang yang bertambah untuk etak dalam rawatan FSP ialah 1.63 ± 0.34, 1.43 ± 0.13 dan 1.57 ± 0.14. Bagi etak yang berada dalam rawatan kawalan, peratus terbaik bagi purata berat, tinggi dan panjang bertambah ialah 1.60 ± 0.33, 1.37 ± 0.15 dan 1.60 ± 0.34. Hasil dapatan daripada keputusan menunjukkan hampas soya yang diperam boleh digunakan sebagai sumber makanan untuk etak.

Kata Kunci: *Corbicula fluminea*, hampas soya yang ditapai, produk sampingan

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LIST OF ABBREVIATION AND SYMBOL

FSP	Fermented soy pulp
L.O.1	Loss on ignition
OM	Organic matter
s.d	Standard deviation
=	Equal
≠	Not equal
kg	Kilogram
ml	Millilitre
cm	Centimetre
mm	Millimetre
±	Plus minus
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Research background

Corbicula fluminea or also more known as Asian clam is one of the aquatic bivalve mollusc. The clam was categorized under the family of *Cyrenidae*. It also well known to be such a rare food source that also well known as popular delicacies to the Malaysian especially for those who were originated from the east part of Peninsular of Malaysia which are in Kelantan and Terengganu. The clams were believed to be originated from the Asian region hence the common name as Asian clams or Asiatic clams were proposed (Illari et al, 2008). The other common name for these clam is gold clam.

Semi closed system is one of the aquaculture system that has been widely used by the farmers from worldwide. Generally, the system was applied on the land-based production in aquaculture. The water in this system were exchanged simultaneously between fresh water and the water from the culture ponds. In this experiment, the aerator was used in both tanks as it to show the significance of the water flowing. The water was pumped into the aerator to increase the level of dissolved oxygen in the tanks. Culture system is used in the aquaculture production as the interaction between the exploited aquaculture species and the relation with biotic and abiotic components that would define better ecosystem environment (Gruss et al, 2015).

As the soybean industry in term of product has been expanded steadily throughout the whole world, this also corresponding with the increasing amount of the waste from the industry (Shuhong Li et al, 2013). the waste also become the major problem to the environment as the waste can actually contaminated the environment and eventually become one source of the pollution. The residue or the by-product of those soybeans can be utilized in many ways including become the feed source to the livestock and aquaculture animals.

The Asian clams have played importance roles towards the environment and also to the humankind itself. It can serve as the food source to the people. For instance, Chinese immigrants were believed to be the one who responsible introduced the Asian clams into the US as the specimens where only found in early 1930s where the timeline was concurrently with the immigration record (Counts, 1986, Illari and Sousa, 2014). The clams also assume have played roles in biotic interactions. The lived and dead shells of Asian clams have alternate the substrate composition which resulting to more attractive and complex habitat were built.

The characteristics of the Asian clams can be distinguished from the other species of clam as it got thick shell which that has shape of triangular and also has distinctive growth rings. Generally, these clams were small in sizes with got range of sizes between 2.5cm in term of length. In rare occasion, there were clams that reached till 6.5 cm in term of length. The shells were ornamented with the polished, light and finely serrated teeth. The outside layer of the shell was normally yellow green while on the inside of the shell it got slightly purple colour (Komaru et al, 2013, Vidal et al, 2017).

1.2 PROBLEM STATEMENT

This research involved in the evaluation of the growth performance of the Asian clam, *Corbicula fluminea* in the semi closed system that fertilized by the fermented soy pulp or treated soy pulp. The presence of the fermented soy pulp can be used to determine the growth rate performance of the clams. In the previous study, the application of the animal manure as the fertilizers already been used. However, the information of the fermented soy pulp as the fertilizers for the Asian clams is still seldom mentioned.

1.3 HYPOTHESIS

H_o: One in control and fsp = growth performance

The Asian clams in control and fsp tanks are equal in growth performance.

$H_{1:}$ All in control and fsp ≠ growth performance

The Asian clams in control and fsp tanks have differ in growth performance.

1.4 SCOPE OF STUDY

The sample from the control and fermented soy pulp tanks were distinguished in term of the growth rate performance. This study involved the determination of the growth performance while focusing on the organic matter content in the tanks both in control and also fermented soy pulp.

1.5 SIGNIFICANCE OF STUDY

The growth performance of the Asian clams was observed and the data were collected throughout this research. The highest growth performance rate in the research has also been identified within the Asian clams in the tanks. The outcome of the research should be useful to the soy industry as the formation of the feed can be made by using the by-product of the soy milk. As the Asian clam being one of the rare delicacies in Kelantan and Terengganu, it also can be useful for the farmers that intends to expand the Asian clam industry by selling it to the food vendors. The outcome of this research is also important for those in soybean industry as the utilization of the soybean waste can be used to make aquaculture feeds. The data that was collected in this research also can be established in the formal database for the future references to provides information to the people. Therefore, more information that related to the Asian clams, *Corbicula fluminea* can be added into the database that can be used for the future references.

1.6 OBJECTIVE

To evaluate the growth performance of Asian clam, *Corbicula fluminea* in semi closed system fertilized by fermented soy pulp.

CHAPTER 2

LITERATURE REVIEW

2.1 Asian clam, *Corbicula fluminea*

Corbicula fluminea was also known to people apart from the one that involve in scientific research as Asian clams is the one of the bivalve mollusc species from the family of Cyrenidea. According to Vidal et al (2017), Asian clams is an invasive freshwater bivalve which is native in Asia, the Middle East, Australia and Africa. This can be supported by Illari and Sousa (2011) in their research by stating that the Asian clams was indeed one of the most invasive bivalve in the aquaculture ecosystem that can change the areas that it was invaded by changing the level of filtration rates and water clarity. It also alternates the faeces content in the ecosystem and the addition of the shells actually changing the physical properties at the bottom sediments of the area. Ultimately, the Asian clams was declared as one of the 100 worst invasive species in the Europe by the DAISIE (2009).

The distribution of these species were believed to begin at the beginning of the century however as stated by Illari and Sousa (2011) the precise distribution of the clams was still controversial as it mainly due to the accurate filiation of these clams. As the origin of the clams was still cause dispute between the researcher, the record for the live specimen that brought into the US were tract during the early of 1930s (Counts, 1986, Illari and Sousa, 2011). As indicated by Pigneur et al (2014), the Asian clams has been showing to have asexual androgenesis as its reproduction system. It means that the Asian clams will be having the off spring with an identical nuclear genome other than the progenitor. However, the claims can be contended by Vidal et al (2017) whom indicated that the asexual androgenesis of the clams cannot be imposed to all of the species.

2.2 Taxonomy

The Asian clams is known to have thick hard distinctive shells with yellow and brown outer part while slightly purple on the inside. These claim was supported by the Komaru et al (2013) by stated that the clams were classified into two type based on the colour of the shell which was yellow for type I and brown for the type II. Wand et al (2014) argued that the haplotype distributions of the mitochondrial gene and nuclear ribosomal gene did not match with the distribution of the shell colour types. As stated by the Pfeningger et al (2002), Hdetke et al (2008), Pigneur et al (2014) and Vidal et al (2017), the three main descends of the invasive species were based on then shell morphology and the molecular analysis.

Many study including Illari and Sousa (2014) and Vidal et al (2017) has indicated that the Asian clams were actually a native of Asia, Middle East, Africa as well as Australia. Even the clams were claimed to be native for these regions, the status of these clams were considered as being confused for the other part of the world as the clams were claimed to have been rapidly expanding as well as the range of the species also increased. As studied by Wang et al (2014), Corbicula itself has a wide native distribution and that may have comprised a large number of the estuarine and freshwater species. The Asian clams was identified in terms of the size of gills, shape of the shell, siphonal tentacles disposition as well as the pigmentation of the area around siphons. The length, height and the width of the clams also used to identify the Asian clams. The taxonomy of the Asian clams, *Corbicula fluminea* was shown as below

Kingdom	Animalia
Phylum	Molussca
Class	Bivalvia
Order	Veneroida
Superfamily	Cyrenoidea
Family	Cyrenidea
Genus	Corbicula
Species	*C. fluminea*
Binomial name	*Corbicula fluminea*
Synonyms	*Tellina fluminea*
Common name	Asian clam, Asiatic clam, Gold clam

Source: (Moretzsohn and Barrera. 2006)

2.3 Fermented soy pulp

Soybeans has been considered as one of the important crop to the Asian especially for the one in the East part of Asia like China, South Korea and Japan. The industry of the soybean products has been well known all around the world. Soybean content were widely known as got high content of the proteins, vitamins, minerals, fibre and also got low content of saturated fat. All of the claims were supported by Xu and Jayachandaran (2019) in their recent study. According to Li et al (2013) there was corresponding increases between the quantity of the soybean residue with production of the soybeans product worldwide. The residue of the soybean also known as the soybean pulp. As the soy pulp was usually throw away after the milk was processed, it was become quite a problem as the pulp was considered to become contaminants to the environment and can lead to the pollution. As stated by Li et al (2013), the pulp has a lot of nutrition hence the utilization of the pulp should be a way to avoid the pulp from being throw away like the industry done.

Fermentation is one of the method that usually use to preserve and also produce other products. In this research, fermented soy pulp was used as the fertilizers that was mixed with the sand to increase the concentration of the organic matter in the tanks. Since the pulp is also part of the soybeans hence it indeed also contained the same nutrition as other soybeans product. According to Messina (2016), soybean product has been proven to be effective to decreased the lipid level in the hyperlipidermics animals. Hence, it certainly can be used to make as animals feed no matter whether it was for the livestock animals or the aquaculture species. So, it was acceptable to use fermented soy pulp as the fertilizers to the Asian clams. As mentioned by Li et al (2013) the soy pulp was famously known to be inexpensive source of protein that is extensively known for its high nutritional and excellent functional properties. Therefore, the claim that the soy pulp was suitable to become animals feed were supported by the researchers in their study like Hong et al (2009).

The soy pulp or the soy residue can be utilized into many products which includes product that required fermentation process or the one that does not need to undergoes fermentation process. According to Li et al (2013) fermentation process resulting in decomposition of insoluble polymer material into soluble low molecular weights compounds.

2.4 Semi closed system

Semi closed system in aquaculture was referred to the movement of the water in the system where the water will flow from the aquaculture pond into the naturals source of the water. According to Buttner et al (2008), semi closed culture system was aim to producing products in the culture at greater densities that will be exceed those in the nature. However, these culture systems require more hands on management and investment of energy. More modern method has been used in these culture system such as pond, cage or net pen culture. The works that need to be done in order to build semi closed system were included pumping water, providing continuous aeration and adding commercial feeds. The authors also emphasized that even the system can bring huge production or biological return it also can increases the production cost and waste and also increase the chances for catastrophic loss.

2.5 Importance and impact of Asian clam

The Asian clams have its own significant importance. The clams could be food source to the humankind. This statements can be supported by Counts (1986), Illari and Sousa (2014) that states that the Chinese immigrants that migrate to the US during the early 1930s brought along Asian clams together with them as a food source. The Asian clams also play roles in determine the economic impact. As the Asian clams is invaded the area that responsible for important roles such as water supply for drinking or provision of cooling water for a power plant, all of the activities will be disturbed. The negative impact on the economic will be occur. A statement by the Illari and Sousa (2014) was that the Asian clams was not physically attached to the structures however it will become the biofulling problems. As the importance and also the impact of the Asian clams still lack of information thus further study was needed to find out more information regarding that matter.

2.6 Ecology and distribution

Asian clams usually preferred shallow, well oxygenated and sandy substrates floor of the freshwater source whether in river or the reservoirs. The authors such as Sousa et al (2008) also agree with that statement. The Asian clams just like other invasive clams, Asian clams is highly successful coupling the nutrient in the water and also organic matter in the sediments. Asian clams will have filtered out the phytoplankton and other suspended particles in the water as those were actually feed source for the filter feeding organism. Asian clams were claimed to used pedal foot to feed on organic matter. The effect of Asian clams in the natural ecosystem were reported quite disturbed same with the report of invasion of zebra mussels. As reported by Vohmann et al (2010), Asian clams has high filter capacity thus make it such a competition for feed with the other filter feeding organism in the ecosystem. The filteration of the Asian clams were depend on the temperature, the concentration of the phytoplankton, season, food concentration and feeding density. These of the factors were seek by the Fallise et al (2014). When the populations of the Asian clams are dense, the significant amount of the inorganic nutrients particularly nitrogen were excreted thus stimulate the growth of the algae and also macrophytes. This statements were also supported by authors Sousa et al (2008) in their research finding.

Despite other research were highlighted the negative impact of Asian clam on the native species the authors like Sousa et al (2018) has concluded that the Asian clams actually does not bring too many negative impact towards the native species. There was too much weak evidence that could be presented to claim that Asian clams was actually bringing negative impact on the native species. The mortality event of the Asian clams that occur during summer which then followed by the release of nutrient through decomposition will bring along negative impact to the water quality. The mortality event also left behind other thing like shells of the dead Asian clams. Those shells provide hard substance to that soft sediments which can helping creating new habitat for the organisms that preferred hard materials as its habitat.

The expansion of the Asian clams was believed due to its nature that have characteristics that help the clams to rapidly expand. According to Falisse et al (2014), Asian clams have rare form of asexual reproduction. The descendants of the Asian clams will eventually actually a clone of the father which make it abnormal compared to usual reproduction whereas the clones will come from the mother.

CHAPTER 3

METHODOLOGY

3.1 Materials and apparatus

In this research project, 120 samples of Asian clams, *Corbicula fluminea* were taken from the selected locations which was located in Pasir Mas, Kelantan. The samples were taken back to the laboratory for the further observation that would be recorded in determine the growth performance of the Asian clams. The clams were put into the tanks that contained tray that hold sand with organic matter and the control sand. 10kg of sand and 1 kg of fermented soy pulp were used in this research. Both of the material were weight out using a scale with the accuracy of 0.01kg. Chemical reagents that needed to be used in this research were Hydrogen peroxide (H_2O_2) and sulphuric acid (H_2SO_4). Both of the chemical reagents required in this research were 70ml, 100ml beaker were used to held the reagents. The dilution process of the chemical reagents will be held in the fume hood. The aeration machine was used in this research to increase the level of dissolved oxygen in the tanks. The parameters that were used in order to achieved the objective of the research were the weight of the Asian clams, the length of the Asian clams and also the height of the Asian clams using the electronic scale and the Vernier callipers that were got precise measurement of 0.000g and 0.05mm on main scale and 0.002 on the Vernier scale. The organic matter content in the sand also measured by doing the analysis on the sand using the oven, furnace and desiccator. All of the parameters were applied on the 120 Asians clams throughout five weeks' periods.

3.2 METHOD

3.2.1 Sample collection

A total number of 120 samples were purchased from wet market which was Pasir Mas, Kelantan. The coordinate of the location has been recorded. The coordinate for Pasir Mas (6.0424° N, 102.1428° E). The Asian clams were randomly collected from the locations. The samples were checked further to ensure whether it still alive or dead. The sample was selected if it closed both of its shell because dead shell has opened both of their shell. Only samples that lived were allowed to taken back to the lab to do further observation. After the purchasing process, the clams were immediately put into the smaller tanks that have aeration machine to prevent the level of the dissolved oxygen in the water decreases.

3.2.2 Sand preparation

In this research, there a total 10 kg of sand was used for the research purpose. The sand was originally collected for about 40 kg from the river near the Agro Techno Park (ATP) which was located in the Universiti Malaysia Kelantan, Jeli campus. The sand that were collected was dried out under the sunlight for a certain period. The drying process was done once the sand was completely dried out. Then, the sand was undergoing the sieving process. The only sand with the size of 0.14 mm. After the sieving process, the sand was kept for a while and to be used for mixing process. The chemical reagents used which were sulphuric acid and hydrogen peroxide. Both of the reagents got 100% concentration hence the dilution process will be required until it reach 1% concentration. All of the process were done in the fume hood. 1kg of fermented soy pulp was mixed with the 70ml hydrogen peroxide.

All of the mixture were mixed well and put aside for 15 minutes. Then, 70ml of sulphuric acid was added into the mixture and mixed well. The mixture was dried out under the sunlight until it was completely dried. After all of the materials dried out, the mixtures of fermented soy pulp, sulphuric acid and hydrogen peroxide were added into the sand and mixed again. When the sand already well mixed, it was transferred into the trays that was put into the tanks and act as the tanks that got fertilized by fermented soy pulp.

3.2.3 Tanks preparation

Two tanks were required in order to carried out the research. The tanks that were used in this research were originally belong to aquaculture lab of Universiti Malaysia Kelantan hence there was no enquiry to buy the new one. The tanks were cleaned both inside and outside. The ethanol with lower concentration were applied to ensure no pathogens were attached to the tanks. After the tanks already clean and dried out, the water was put into the tanks. The last step was put the aerator machine into the tanks and the machine was always turn on until the last period of research.

3.2.4 Sample preparation

The collected samples were examined and observed for further collecting information process. The Asian clams were weight out on the electronic scale with the accuracy of 0.0000g to get the starting weight. All 120 samples were weight before the samples were put into six trays that will hold 20 samples of Asian clams in it. The trays were put into the tanks that separate the control group and also the tanks that have been fertilized by the fermented soy pulp.

3.2.5 Growth measurement

For the five week periods of research, the samples were measured for its weight, length and width once a week. The process take place in the first day of the week. The sample was weight out in the first week to get the initial reading of the parameters. All of 120 samples was weight out on the electronic scale with accuracy of 0.000g. The sample was weight to determine whether it gain or lose weight every week from first week until week five. The process was have rotated that was start with the samples from the tanks that was fertilized with fermented soy pulp and continue with the control tanks. After the weighing process, the measurement of the length and the height of the samples were took place. The samples were measured based on the length and the height to determine either the growth increased or decreased.

3.2.6 Organic matter determination

The determination of the organic matter in the sand can be known through the loss of ignition (LOI). The process started with the sediment or the sand was collected from both of the tanks during the same day where the measurement of the parameters process occurred. The sediments were collected and dried out in the oven under 60°C for about 1 hour. After 1 hour, 2g of the sample was weighed on electronic scale and the sample was heated up till 550°C in the furnace for a period of 4 hours. After the heating process, the sample was into the desiccator for 30 minutes to cool down the sample. The sample was reweighed to calculate the percentage of organic matter. The calculation was made by using the following formula

$$\% \text{ OM} = \frac{\text{before ashing (g)} - \text{after ashing(g)}}{\text{before ashing(g)}} \times 100\% \qquad (3.1)$$

3.2.7 Statistical analysis

The data that were collected throughout the periods were analysed statistically. The values were presented as the mean and the standard deviation need to be done in order to get the precise value. The raw data that were collected need to be changed into the allometric data so that it can be presentable. The growth performance and the percentage of the organic matter has to be analysed by using one-way analysis of variance (ANOVA) (Hamli et al, 2015). the significance differences were tested at ($p < 0.05$) (Hamli et al, 2016).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Result

At the end of the experiment period, data that have been collected were analyzed by treatment based on weight, length and height of the Asian clam (*Corbicula fluminea*). The total periods for this research is five weeks. Data for all two treatments were analyzed and summarized in the graph form. The correlation between weight, length and height by using fermented soy pulp were analyzed in Table 4.5.

4.1.1 Weight of Asian Clam

Throughout the experiment activity, the initial weight of 120 samples of Asian clam for each treatment was weighed. Data for increment weight after five weeks of experiment period was analyzed using Statistical Package for Social Science (SPSS) software version 23.0

From the table 4.1, the percentage (%) mean of weight increment is highest in FSP treatment with the value of 1.63 ± 0.34 while compared to control treatment which only got value of 1.60 ± 0.33. However, there is no significance difference for both of the treatment.

Table 4.1: Table shows the Percentage (%) mean of weight increment (±s.d.) for Asian clam (*Corbicula fluminea*). The data has no significance difference

Treatment	Percentage(%) mean of weight increment (g)(**±s.**d.)
FSP	1.63 ± 0.34
Control	1.60 ± 0.33

From the figure 4.1, the graph showed the mean of weight for the FSP treatment was increased from week 1 to week 2 with the value of mean of weight 1.6432 g to 1.6482 g in the second week. The mean of weight for FSP treatment however has shown in decreasing value from week 2 to week 3. In the second week the mean is 1.6482g then it decreased to the value of 1.6306 in the third week. The decreasing mean of weight was continued to week 4 and final week. The mean of weight for the week 4 is 1.6238g and the final mean of weight for the FSP treatment in the final week was 1.6033g. Factor such as mortality seem to become major reason of the decreasing weight of Asian clam.

The Figure 4.2 was showing the mean of weight for the control treatment. The mean of weight for control treatment has shown increased value from 1.6025g in the first week to 1.6091 g in the second week. Then, the mean was slightly decreased during the third week with the value of mean is 1.6090g and it continued decreased during week4 with 1.5814 g. During the final week, the mean of weight for the control treatment has shown increasing to 1.6024 g.

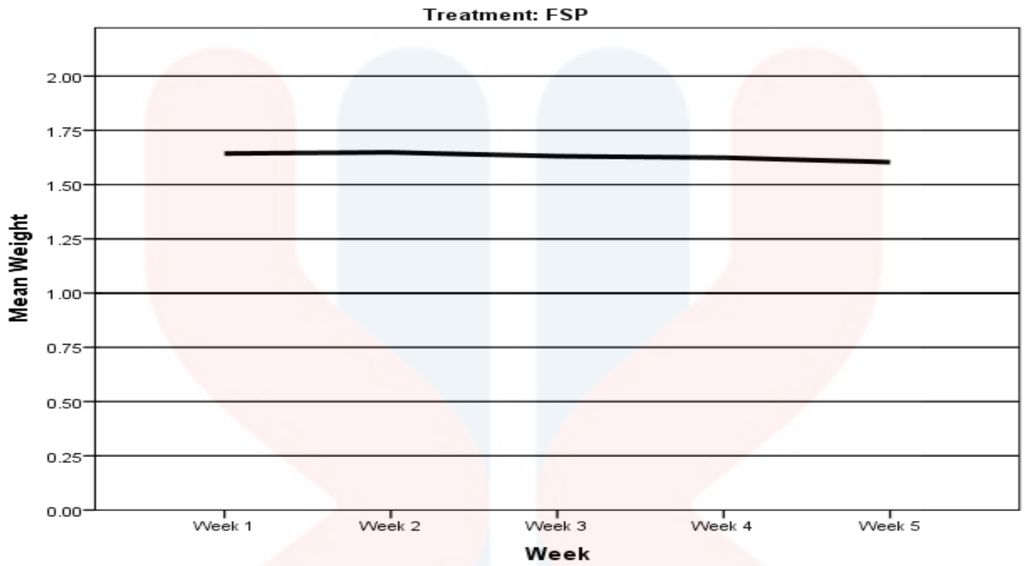

Figure 4.1: The graph showed the mean of weight of Asian clam (Corbicula fluminea) in FSP treatment for the five weeks

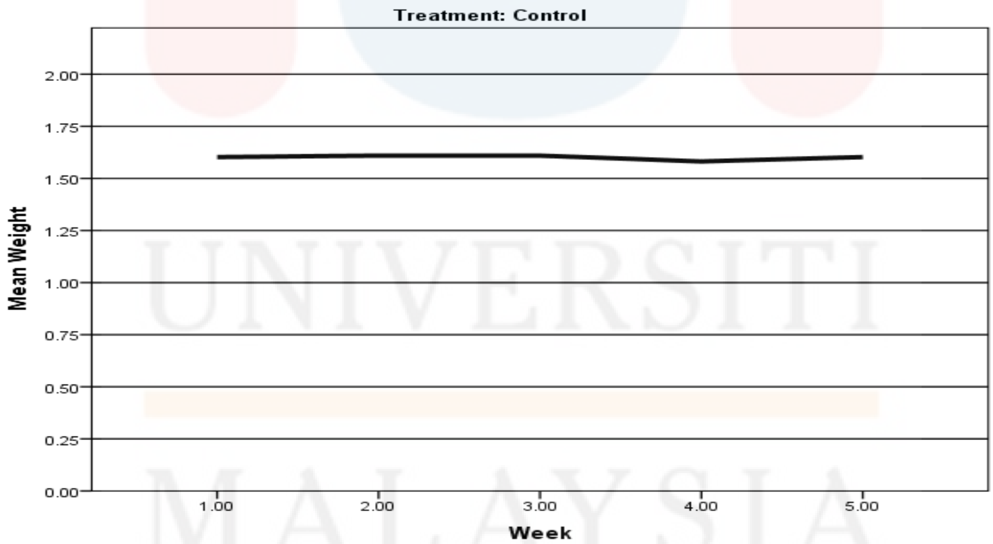

Figure 4.2: The graph showed the mean of weight of Asian clam (Corbicula fluminea) in the control treatment.

Based on the result, there is no significance difference in the mean of weight for each of the treatment. The Asian clam that was in the FSP treatment has showed percentage of weight increment with the value of 1.63 ± 0.34 while the Asian clam in the control treatment has showed the percentage of mean weight increment for the five week periods with the value of 1.60 ± 0.33. From the result that have been obtained it showed that the FSP can be the feed source for the Asian clam. Asian clam can obtain the nutrient from FSP through filter feeding but it was still not clear either the nutrient that it obtained was enough for Asian clam nutrient requirement. Based on the nutrient content in the fermented soy pulp, it was rich with crude protein, crude fiber and other respective nutrient. The other nutrient that were remained in the fermented soy pulp is Potassium, Calcium and niachin. One of the main important factor that contributing to the weight gain of Asian clam for the whole period of research is Calcium as it is important in growth of shell and also metabolism of the Asian clam.

Based on the Figure 4.1, the mean of weight gain of Asian clam in the FSP treatment was only showed increasing in value during week 1 to week 2 only and it kept decrease from the week 2 until the final week. The factors that may contribute to such occasion is due to mortality that occurred throughout the experiment period. Nutrient such as protein, fiber and lipid that were contained in the FSP does not ensure the weight of the Asian clam kept increases. The fermented soy pulp does contain high protein content like stated in Attakpa et al (2015) and suitable to become feed source however in this experiment, the mean of weight of Asian clam kept declining over weeks due to others factor either it environmental factor or others factors.

Figure 4.2 showed the mean of weight of Asian clam in the control treatment. As the mean of the Asian clams in control treatment have been increased from week 1 to week 2, it showed that the Asian clam in the control treatment can obtained feed from the phytoplankton in the water. Since the research was solely focusing on the fermented soy pulp thus the it will not be discussed in this report. The Asian clam in control treatment has shown kept decreasing in weight from week 2 to week 4 and then it increases during the final week. Both of the treatment has shown no significance difference towards each other. The presence of fermented soy pulp in the FSP treatment has become component that differentiate the treatment also become one of the element that contributing the weight gained of Asian clam.

4.1.2 Height and Length of Asian clam

From the table 4.2, the value of Percentage of mean of height increment for Asian clam (Corbicula fluminea) in the FSP treatment is 1.43 ± 0.13 while compared to the Asian clam in the control treatment, it got 1.37 ± 0.15 as the mean of height increment.

Table 4.2: Table shows the Percentage (%) mean of height increment (±s.d.) for Asian clam (*Corbicula fluminea*). There is no significance difference.

Treatment	Percentage(%) mean of height increment (cm)(±**s.**d.)
FSP	1.43 ± 0.13
Control	1.37 ± 0.15

The graph below showed the mean of height for each week for the five week periods for both treatments. The Asian clam in the FSP treatment has showed increasing mean from the first week till the third week. The first week recorded value of mean of height is 1.3875 cm and it increase to 1.3923 cm. the Asian clam kept recorded increase value of mean of height in third week with the value of 1.4693 cm. However, the mean of height for the Asian clam in the FSP treatment has shown decreased during the fourth week with the mean value of 1.4344 cm. The Asian clam in the FSP treatment has showed increased mean of height during the last week with the value of 1.4726 cm.

The other graph showed the mean of height gain in Asian clam that was put in control treatment. Overall, the mean of height gained in the control treatment has constantly increasing. During the first week, the mean of height has value which is 1.3359 cm and it increased to 1.3583 cm in the second week. The third weeks has maintained increased trend of mean of height increment with 1.3780 cm and it kept increased to 1.3989 cm in the fourth week. The final mean of height gained for the Asian clam in the control treatment is 1.4050 cm.

Graph in the Figure 4.3 was showed the mean of height of Asian clam in FSP treatment while in Figure 4.4, the graph showed the mean of Asian clam in control treatment. The mean of height in FSP treatment was continuous increasing for three weeks straight however due to other factor such as mortality has cause the mean of height of Asian clam in FSP treatment to slightly decreases during the fourth week however it then increases during the final week. The mean of height of Asian clam in control treatment has shown increasing pattern from the first week until final week.

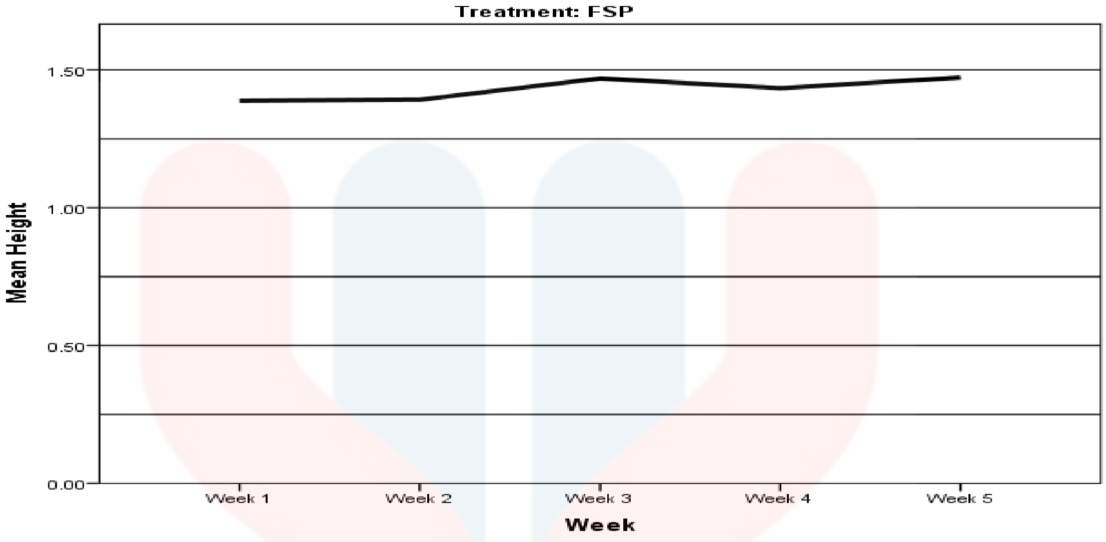

Figure 4.3: The graph showed the mean of height of Asian clam in FSP treatment

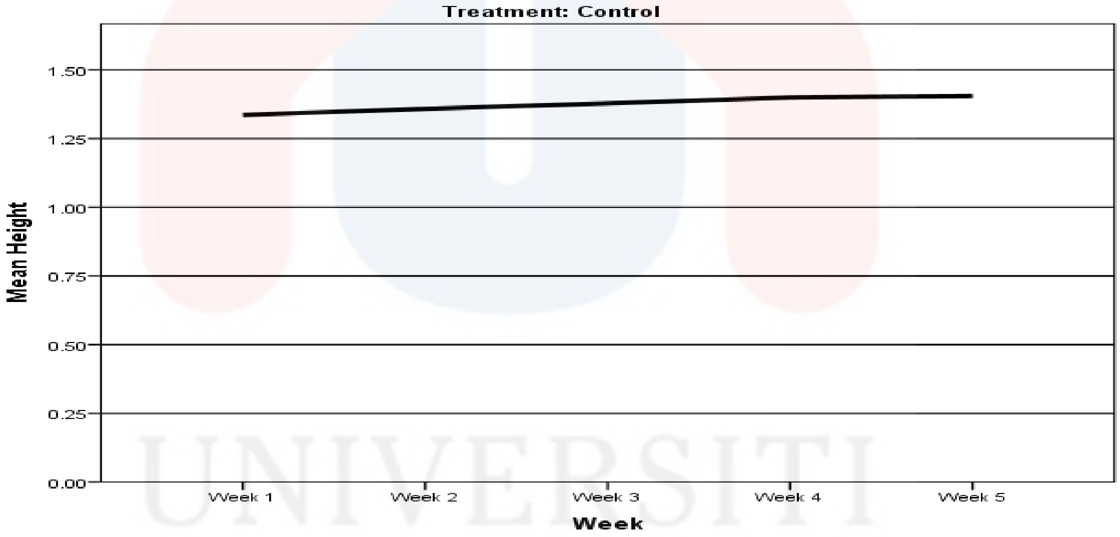

Figure 4.4: The graph showed the mean of height increment of Asian clam in control treatment.

Based on the result, the Table 4.3 has showed the percentage of mean of length gain in the Asian clam in the FSP and the control treatment. The Asian clam in the FSP treatment has shown the value of 1.57 ± 0.14 as the mean of length gain while the

Asian clam in the control treatment has showed 1.60 ± 0.34 as the mean of length increment in the research period.

Table 4.3: Table shows the Percentage (%) mean of length increment (±s.d.) for Asian clam (*Corbicula fluminea*). There is no significance difference

Treatment	Percentage(%) mean of length increment (cm)(**±s.**d.)
FSP	1.57 ± 0.14
Control	1.60 ± 0.34

The graph below showed the mean length of increment in the FSP treatment. The mean of Asian clam in the FSP treatment has showed increased from week first till week3. In the first week, the mean of length increment is 1.5381cm and the value 1.5602 cm in the second week. The third week recorded 1.6139 cm in the third week. Then, the value of mean of length increment in fourth week decreased to 1.5674 cm and it kept decreased to 1.5674cm in the final week.

The other graph showed the increasing trend from week one till week 5. The mean of length in the first week is 1.5481 cm and it increased to 1.5659 cm in second week. The third week showed the mean was increased to 1.1.5814 cm and it kept increased to 1.6070 cm in the fourth week. The final week has shown the record of mean of length increment is 1.6125 cm.

During the period of research, the height and length of the Asian clam were look to be greatly linked with the presence of fermented soy pulp in the fermented soy pulp treatment as it showed to have higher mean of height and length in Asian Clam in FSP treatment compared to control treatment. Calcium is one of the nutrient that played major role in the growth of shells of Asian clam as the low concentration of the Calcium can negatively impact the growth of Asian clam. During maturation stage of Asian clam, the average height of the Asian clam is 0.6 till 1.0 cm. This statement was supported by Caffrey et al (2011).

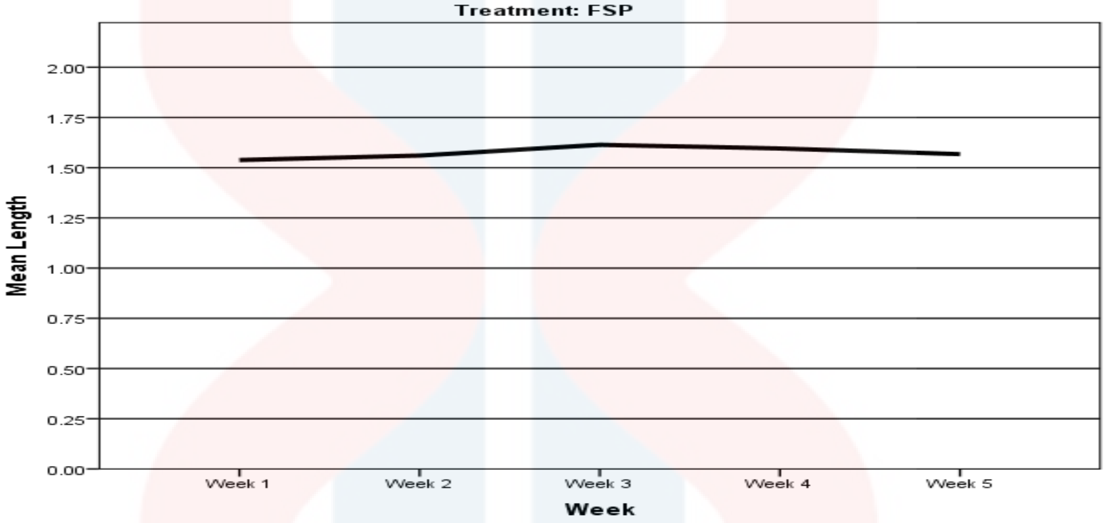

Figure 4.5: The graph showed the mean increment of length of Asian clam in FSP treatment

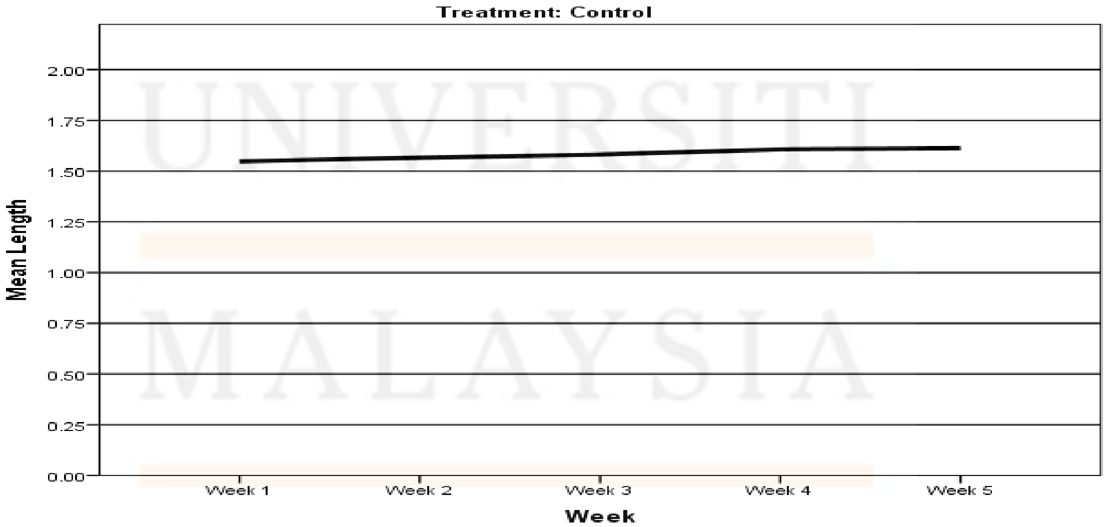

Figure 4.6: The graph showed the mean increment of length of Asian clam in control treatment

4.1.3 Percentage of Organic Matter

Based on the result in the Table 4.4, the percentage of organic matter of sand of FSP treatment is the 0.20 ± 0.0 g while for the control treatment the value of percentage mean of organic matter is 0.25 ± 0.02 g.

Table 4.4: Table shows the Percentage (%) mean of organic matter in sand

Treatment	Percentage(%) mean of organic matter of sand (g)(**±s.**d.)
FSP	0.20 ± 0.0
Control	0.25 ± 0.02

Graph in Figure 4.7 showed the average mean of percentage of organic matter in the sand in FSP and control treatment. Percentage (%) of organic matter in FSP treatment is 0.20 while 0.25 in the control treatment.

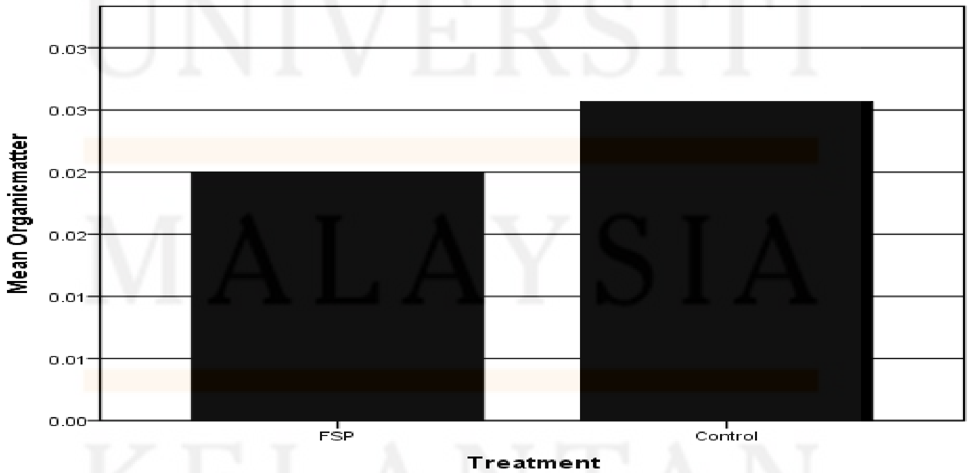

Figure 4.7: The graph showed the mean Percentage (%) of organic matter

During the five weeks' experimental period, the organic matter of the sand was examined once every week. Form the examination, the result that has been obtained is 0.20% or organic matter in the sand that was in FSP treatment. The mean percentage for the organic matter in the sand of control treatment has showed 0.25%. The result that has been obtained was for overall period of experimental. The organic matter content in the soil was referred to the sediment that was fed by the Asian clam. As for the Asian clam in the control treatment, the clams were not fertilized by the fermented soy pulp thus make it only reliable to phytoplankton and also the sediment in the sand as the feed source, Dias *et al* (2014) have been stated in their research that although the majority of the feed sources of the Asian clam was filtered from the water, Asian clam also relied on the organic matter sediment and microphytobentos as a feed source. Hence it showed that the organic matter sediment truly important to the growth of the Asian clam.

Asian clam in the FSP treatment has shown bigger value on growth measurement of weight, height and length compared to Asian clam in the control treatment even though the percentage of the organic matters sediment in the control treatment was higher than in FSP treatment. The factor that may contribute to this result may due to the additional of FSP in the sand that was in FSP treatment that make it low percentage compared to the one in the control treatment. Since there was no other feed source other than phytoplankton in the water, Asian clam in the control treatment use the organic matter sediment in the sand to become their other alternative feed source thus make it higher than the FSP treatment.

4.2 Correlation between Weight, Height and Length

Based on the table 4.5, the correlations between percentages (%) mean growths in weight (g) increment, percentage (%) mean height (cm) and percentage (%) mean length (cm) for Asian clam. The correlation between weight to height and length is 0.455 and 0.554 while the correlation between height and length is 0.587. The result that has been obtained showed that there was a weak correlation between percentages (%) mean growths in weight (g) increment, percentage (%) mean height (cm) and percentage (%) mean length (cm) for Asian clam (*Corbicula fluminea*) as the weight, height and length are significantly correlate at the $p<0.01$. Any increase of weight (g), height (cm) and length (cm) was not strongly influenced towards each other.

Table 4.5: Table shows correlation between percentages (%) mean growths in weight (g) increment, percentage (%) mean height (cm) and percentage (%) mean length (cm) for Asian clam (*Corbicula fluminea*)

		Weight (g)	Height(cm)	Length(cm)
Weight	Spearman's rho	1.00	0.455	0.554
Height	Spearman's rho	0.455	1.00	0.587
Length	Spearman's rho	0.554	0.587	1.00

Based on this experiment, the increase of the weight was due to feed intake by the Asian clam in FSP treatment has been influencing the increasing in height and length. As the Asian clam has variety of feeding strategies such as has higher filter capacity may also contribute to the weight gain of Asian clam (Dias *et al*,2011). At the end of experiment, different feed intake by each of the individual can be seen through the total of weight increment in Asian clam in FSP treatment compared to control treatment.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

From this study, the weight increment (g) of the Asian clam after fertilized by the fermented soy pulp has shown result such as the weight in FSP treatment has been decreased from week 2 until final week and only shown increase during the first week. The result continuous to height (cm) and length (cm) increment as it showed increase and decreased pattern throughout the period of experiment compared to the result obtained in control treatment which only show positive result with increase in weight (g), height (cm) and length (cm) increment from first week till final week but Asian clam in FSP treatment still has bigger value compared to control treatment. For Spearman's rho correlation, the weight (g), height (Cm) and length (cm) are correlated to each other but it is too weak with the value of0.455 and 0.554 respectively. The correlation between height (cm) and length (cm) is 0.587. As the conclusion, the fermented soy pulp may use as other alternatives feed to be given to Asian clam but it does not give any difference with other feed. Hence the hypothesis of Asian clam in fermented soy pulp treatment has difference in growth with the Asian clam in control treatment was rejected.

As a recommendation based on the present study, the number of sample should be increased in order to set more valid data. The research also need to be monitored every day as to observe the weight, length and height gain of the Asian clam. The percentage of organic matter sediment in the sand should be high in order to add more feed source for the Asian clam. Lastly, this research need to be compared with the group control that were live in imitation of natural habitat

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APPENDIX A

Table A.1: One-way ANOVA for weight(g), height (cm) and length (cm) increment

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Length	Between Groups	.270	4	.068	3.173	.014
	Within Groups	10.648	500	.021		
	Total	10.918	504			
Height	Between Groups	.387	4	.097	5.006	.001
	Within Groups	9.660	500	.019		
	Total	10.047	504			
Weight	Between Groups	.054	4	.014	.118	.976
	Within Groups	57.711	500	.115		
	Total	57.765	504			

Table A.2: One-way ANOVA for percentage of organic matter (%)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.000	1	.000	1.896	.174
Within Groups	.015	58	.000		
Total	.015	59			

Table A.3: Spearman's rho correlation for weight (g), height (cm) and length (cm) increment of Asian clam

			Length	Height	Weight
Spearman's rho	Length	Correlation Coefficient	1.000	.587**	.554**
		Sig. (2-tailed)	.	.000	.000
		N	505	505	505
	Height	Correlation Coefficient	.587**	1.000	.455**
		Sig. (2-tailed)	.000	.	.000
		N	505	505	505
	Weight	Correlation Coefficient	.554**	.455**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	505	505	505

**. Correlation is significant at the 0.01 level (2-tailed).

Table A.5: Descriptive table for weight (g), height (cm) and length (cm) increment

Treatment			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
FSP	Length	Week 1	57	1.5381	.11311	.01498	1.5081	1.5681	1.34	1.81
		Week 2	52	1.5602	.12304	.01706	1.5259	1.5944	1.30	1.96
		Week 3	46	1.6139	.15296	.02255	1.5685	1.6593	1.30	2.00
		Week 4	48	1.5958	.16425	.02371	1.5481	1.6435	1.23	2.00
		Week 5	31	1.5674	.14149	.02541	1.5155	1.6193	1.30	1.89
		Total	234	1.5736	.14037	.00918	1.5556	1.5917	1.23	2.00
	Height	Week 1	57	1.3875	.10957	.01451	1.3585	1.4166	1.11	1.82
		Week 2	52	1.3923	.12535	.01738	1.3574	1.4272	1.10	1.89
		Week 3	46	1.4693	.15477	.02282	1.4234	1.5153	1.10	1.92
		Week 4	48	1.4344	.12399	.01790	1.3984	1.4704	1.20	1.86
		Week 5	31	1.4726	.12033	.02161	1.4284	1.5167	1.20	1.80
		Total	234	1.4256	.13117	.00857	1.4087	1.4424	1.10	1.92
	Weight	Week 1	57	1.6432	.34235	.04535	1.5523	1.7340	.99	2.68
		Week 2	52	1.6483	.35582	.04934	1.5492	1.7473	.89	2.69
		Week 3	46	1.6306	.41367	.06099	1.5078	1.7535	.00	2.69
		Week 4	48	1.6238	.31968	.04614	1.5310	1.7166	.90	2.67
		Week 5	31	1.6033	.26257	.04716	1.5070	1.6996	1.01	2.41
		Total	234	1.6326	.34444	.02252	1.5882	1.6769	.00	2.69
Control	Length	Week 1	59	1.5481	.15265	.01987	1.5084	1.5879	1.07	1.95
		Week 2	59	1.5659	.15124	.01969	1.5265	1.6053	1.10	2.03
		Week 3	59	1.5814	.15260	.01987	1.5416	1.6211	1.11	2.05
		Week 4	54	1.6070	.14906	.02028	1.5664	1.6477	1.14	2.07
		Week 5	40	1.6125	.15702	.02483	1.5623	1.6627	1.17	2.01
		Total	271	1.5805	.15301	.00929	1.5622	1.5988	1.07	2.07
	Height	Week 1	59	1.3359	.14557	.01895	1.2980	1.3739	1.05	1.67
		Week 2	59	1.3583	.14474	.01884	1.3206	1.3960	1.10	1.68
		Week 3	59	1.3780	.14553	.01895	1.3400	1.4159	1.12	1.68
		Week 4	54	1.3989	.14268	.01942	1.3599	1.4378	1.14	1.69
		Week 5	40	1.4050	.13989	.02212	1.3603	1.4497	1.14	1.61
		Total	271	1.3727	.14513	.00882	1.3553	1.3901	1.05	1.69
	Weight	Week 1	59	1.6025	.34040	.04432	1.5138	1.6912	.71	2.45
		Week 2	59	1.6091	.35152	.04576	1.5175	1.7007	.72	2.46
		Week 3	59	1.6090	.35178	.04580	1.5174	1.7007	.71	2.46
		Week 4	54	1.5814	.32739	.04455	1.4921	1.6708	.70	2.28
		Week 5	40	1.6024	.28753	.04546	1.5105	1.6944	.70	2.03
		Total	271	1.6012	.33333	.02025	1.5613	1.6410	.70	2.46

APPENDIX B

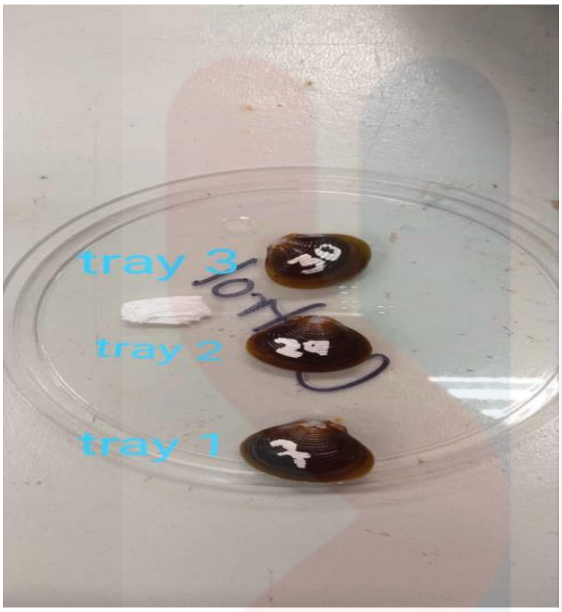

Figure B.1: Few samples of Asian clam from control treatment

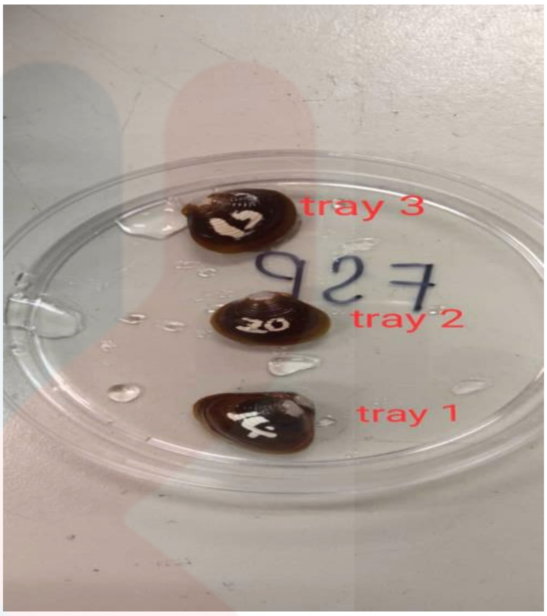

Figure B.2: Few samples of Asian clam from FSP treatment

Figure B.3: Weighing the sand by using electrical weight balance

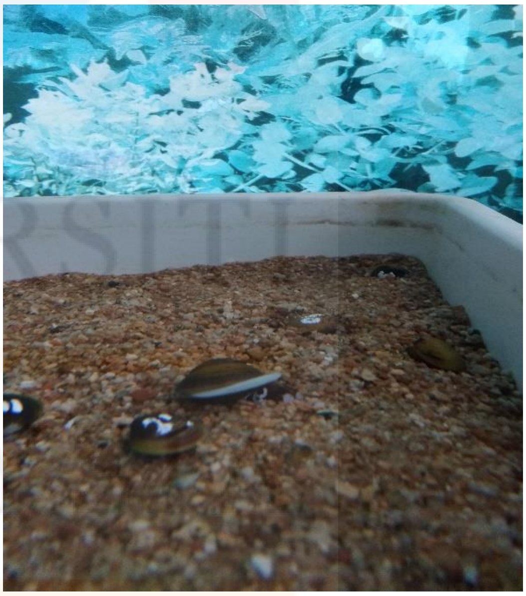

Figure B.4: Asian clam in the control treatment