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Proximate Analysis of Bait Polychaetes from Port Dickson, Malaysia as Prospectus Replacement for Aquaculture Feed

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Abstract— *Bait polychaete worms were obtained from areas around Port Dickson coasts of Negeri Sembilan Darul Khusus in Malaysia. There were four species of bait polychaete species used in this study Perinereis quatrefagesi, Halla parthenopeia, Diopatra neapolitana, and Marphysa mossambica. These polychaete species were subjected to lipid, protein, water, carbohydrate, and ash content analysis. The lipid contents in polychaete were determined using Soxhlet analysis. The protein contents were determined using Kjeldahl analysis. The water and ash content were determined by using the oven drying method. Marphysa mossambica has the highest percentage of lipid as much as 27.98. Diopatra Neapolitana has the highest protein content in their body, as much as 51.87% and followed closer by Marphysa mossambica as much as 51.14% respectively. The highest carbohydrate content was found in the polychaete species Perinereis quatrefagesi, as much as 24.61%. The highest ash content was found in Diopatra neapolitana yet Marphysa mossambbica has comparatively high ash content as well as much as 3.12% compared to 3.24% in Diopatra neapolitana. Similar pattern as in ash content can be seen for water content as well. Diopatra neapolitana has the highest percentage of water as much as 71.38% and followed closer by Marphysa mossambica with water content as much as 70.23%. The biochemical composition in polychaete species varies because of species size, feeding biology, habitat and environmental factor as well. The biochemical composition within species also shows a constant composition even though it varies in terms of value.*

Keywords— ***Bait polychaetes, Perinereis quatrefagesi, Halla parthenopeia, Diopatra neapolitana, Marphysa mossambica, SGR, FCR.***

I. INTRODUCTION

Bait-worms are polychaetes which have been used traditionally by anglers to lure fishes. In Malaysia, baitworms are commonly known by the name 'Umpun-umpun'. Bait polychaetes are known to occupy almost any marine habitat, from sandy shores to rocky shores and mostly in muddy shores. Polychaetes are also found to populate the shallow coastal area as well as deep ocean bottoms for example, the tubeworms found at deep-sea hydrothermal vents [1]. Polychaetes can be differentiated from other annelids by their distinctive external anatomy and morphology[2]. Polychaete has a very complex external anatomy as compared to other annelids. Polychaetes have an elongated and tubular body (Fauchald and Rouse, 1997). Polychaete has a segmented bodyand at each segment of the body, Polychaete has a pair of legs used to swim in the water column and crawl on sediments. These legs are moved by a powerful muscle known as parapodia [4].

Polychaetes of certain species known to have economic importance. The adult and larvae of the polychaeteare part of the food web where they meant to be food for fishes that have commercial value and humans consume [5]. They are also used as bait for recreational fishing. Therefore, they are an animal species that need to

be conserved and to do it successfully we have to study their biology, ecology and distribution [6].

Polychaetes also play a major role by being a keystone species used in biomonitoring of the marine environmental quality, being indicators for toxic materials and pollution [7]. The primary objective of biomonitoring is to access the impact of man-made changes such as the introduction of toxic chemicals on the biosphere [8]. Polychaeteis a suitable class of organism to be used in monitoring the marine environmental quality because throughout most of their life they dwell in the sediment and they are sessile if no interference by an external force to drive them away from their habitat.Their response to compounds introduced by anthropogenic activity is expressed via changes in their reproduction, growth and mortality [9]. Existence of polychaete in abundant, having a short life span and variable habitat range, polychaetes deemed to be suitable for assessing the toxicity of sediments. Wang et al. (2017) suggest that if sensitive polychaete species are absent, and the biodiversity is low, then it can be concluded that the study site is impacted heavily by pollutant introduced by anthroposphere. They respond quickly to changes in environmental conditions thus by continuous monitoring we will be able to detect the impact of anthropogenic sourced pollutant in a particular study site [11]. The ability to observe different stages in the recovery of polluted sites is most likely because the different species of polychaete emergeafter the cessation of the impact [12].

The importance of this study was to analyze the biochemical content of polychaete worms found in Malaysian marine habitats. By analyzing the biochemical contents in these polychaete worms we could list out one or more polychaetes which are suitable to be cultured as aquaculture and mariculture feed product[13]. Currently, most of the farms are operating based on formulated feed pallets which bring several side effects to the fish as well as harming the environment. The use of polychaetes as a substitute of formulated feed in aquaculture or mariculture industries would improve the health of culture stock.

II. MATERIALS AND METHODS

2.1 Sample location and collection

Only fresh samples obtained from the shores of Port Dickson, Malaysia were used in this study. The specimens of polychaetes (*Perinereis quatrefagesi*; *Halla parthenopeia;Diopatra neapolitana*; *Marphysa mossambica*) were collected during low tide at the muddy shores of Port Dickson (Figure 1). The specimens collected were carefully kept in a sampling bottle and transported to the lab to be frozen before further analysis. Each specimens were thawed (defrosted) before analysis.

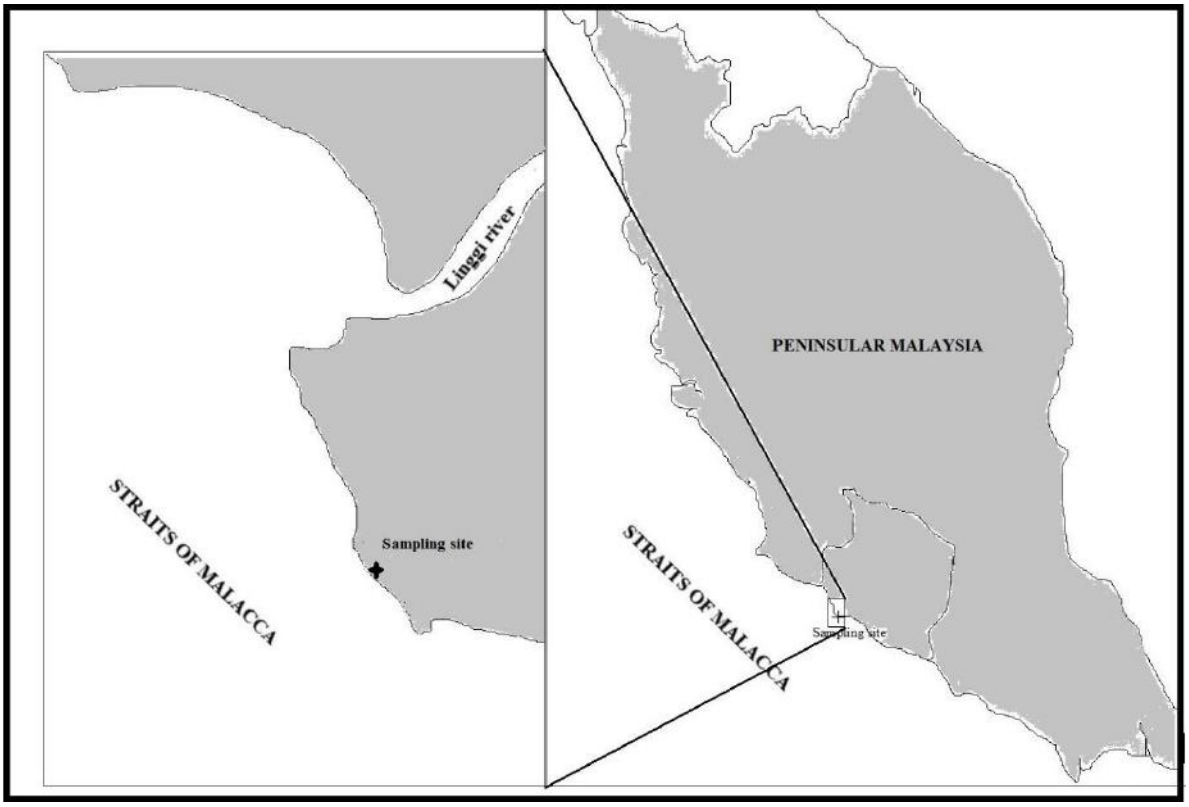

Fig.1: Maps showing the location of Port Dickson in the west coast of Peninsular Malaysia, and location of sample collection at Port Dickson.

2.2 Proximate analysis

2.2.1 Lipid Content Determination by Soxtec System 2043 (Soxhlet Analysis)

a) Sample preparation

The polychaete samples were dried and homogenized. 1-2g of the homogenized sample was weighed on the filter paper (W1). These weighed samples then placed into separate thimbles. The thimble was placed on the thimble holder. A thin layer of cotton was placed on top of the samples. Then the thimbles were moved towards the thimble support.

b) Lipid Collection from sample

The pre-dried extraction cup was weighed (W2). 50ml of hexane was poured into the extraction cup using a measuring cylinder. The extraction cup was placed into the cup holder and the cup holder was attached to the Extraction Unit.

c) Lipid Extraction procedure using Soxtec System (2043)

The 'POWER' Key on the control unit was pressed. The tap water was opened and let to flow for the reflux condenser. The 'PRE-HEAT' button was pressed and the hot plate temperature was set 130ºC to warm up. The thimbles then were attached tothe Extraction Unit. The thimble support was removed and the extraction cup was attached using a cup holder. Then the 'START' key was pressed. The thimble was moved to 'BOILING' position and 'TIMER' key was pressed. The boiling timer was already to 20 minutes. After 20 minutes, the thimble was moved to 'RINSING' position and the 'TIMER' key was pressed again. The time for this process was set as 40 minutes. The condenser valve was closed and the air pump starts automatically. The extraction cup was removed and transferred into the oven to be dried at 100ºC for 30 minutes. The thimbles were removed and the waste solvent was removed. The tap water was closed and the 'POWER' button turned off.

d) Determination of lipid content

The cup was dried at 103ºC for about 30 minutes. The extraction cup was left to cool down in desiccators. The extraction cup was weighed (W3). The crude fat in the polychaete sample was calculated.

Calculations:

$$\% \text{ Fat} = \frac{W3 - W2}{W1} \times 100$$

W1 = Sample weight (g)

W2 = Extraction cup weight (g)

W3 = Extraction Cup + Residue weight

2.2.2 Protein Content Determination by Kjeltec System (Kjeldahl Analysis)

a) Sample Preparation

0.1-3.0g of the sample was weighed into the digestion tube. 1 teaspoonful of catalyst ($CuSO_4$) was added together. 12ml of concentrated $H2_SO_4$ was added. The mixtures were shaken gently.

b) Block digestion

The digestion tubes were placed in the racks. The rack was loaded with exhaust into a preheated (420ºC) digestion block. The tap water was opened. The sample was let to digest until all the samples change into green colour. The rack with digestion tube was removed and left to cool down about 15 minutes.

c) Kjeltec System distillation unit operation (2100)

i. Warming up the distillation unit

The 'POWER' button was turned on. The tap water was opened. 75 ml of distilled water was poured in the digestion tube. The digestion tube was attached into a distillation platform. 25 ml of H_2O was poured to a conical flask. The conical flask was placed on the distillation platform. The safety door was closed. Then 'STEAM' was pressed.

ii. Sample Distillation

The cooled sample then diluted with 75ml H_2O. The digestion tube was attached into the distillation platform. 25ml of 4% boric acid solution was added into a conical flask. The conical flask was placed into the distillation platform. The safety door was closed and the 'ANALYSE' key was pressed. The receiver solution turned green. The receiver solution with the conical flask was removed.

iii. Titration

The receiver solution in conical flask was titrated with 0.1 HCl till the colour changes to red. The Acid volume used up in burette when the solution in conical flask turns red was recorded. The % of Nitrogen present in the sample was calculated.

d) Determination of Protein Content

$$\% \text{ N} = \frac{0.1 \text{ X (Volume of acid – blank) X } 14}{\text{Weight of sample X } 1000} \text{ X } 100$$

% Protein = 6.25 X % Nitrogen

2.2.3 Water Content Determination

The power supply for the oven was turned on. The On/Off key was turned on. The temperature of the oven was set to 100ºC. The samples were placed in a container and the

sample and container have to be weighed. The samples were placed into the oven after the temperature of the oven rises to 100 ºC. The samples were left in the oven for 24 hours. The samples then removed and weighed.

Calculation:

$$\% \text{ water content} = \frac{W1 - W2}{W1} \times 100$$

W1 = Wet weight of polychaete sample.

W2 = Dry Weight of polychaete sample.

2.2.4 Ash Content Determination

The power supply for the oven was turned on. The On/Off key was turned on. The temperature of the oven was set to 200ºC. The samples were placed in a container and the sample and container have to be weighed. The samples were placed into the oven after the temperature of the oven rises to 200 ºC. The samples were left in the oven for 24 hours. The samples then removed and weighed.

Calculation:

$$\% \text{ Ash content} = \frac{W2}{W1} \times 100$$

W1 = Wet weight of polychaete sample.

W2 = Dry Weight of polychaete sample.

2.2.5 Carbohydrate Content Determination

After obtaining all the calculated values of protein, lipid, and ash content, the carbohydrate content in percentage was determined by using the following formula:

Carbohydrate % = 100 − (protein % + lipid % + ash %)

2.3 Growth performance

The growth performance of the based the influence of different diet was tested using (*Oreochromis niloticus*) Tilapia fish. Tilapia fish was chosen for this experiment because it is a common fish consumed by Malaysians and also one of the most bred species in aquaculture industry. Apart from that, Tilapia's are also (young specimens of almost equal size and weight were chosen-able to display growth spurt) chosen for this study because it is easy to handle and they are also a suitable species to be kept and bred in captivity. The growth performance of Tilapia specimens was assessed using three aspects namely; weight gain, specific growth rate, and feed conversion ratio. The effect of different feeds, polychaete-*Diopatra neapolitana* (live feed) and pellet was tested on 2 sets (live and pellet) of triplicate and each tank contains 10 younglings. The Tilapia specimens were fed 10g/kg feed (live and pellet) kept in separate aerated-filtered tanks (volume ~ 20L). The experiment was conducted for a duration of 3 months (12 weeks).

2.3.1 Weight Gain

The weight gain of the specimens will be measured on a weekly interval. The initial weight (wet weight) of the specimen will measured using a weighing scale each week from day 1 and the changes in weight will be recorded to determine the weight gain using the formula stated below:

WG = Final weight – Initial weight

2.3.2 Specific Growth Rate (SGR)

Using the values obtained from weight measurement specific growth rate will be derived using the following formula:

SGR = (ln(final weight in grams) - ln(initial weight in grams) x100) / t (in days)

2.3.3 Feed Conversion Ratio (FCR)

Feed conversion rate was determined using the formula as below:

F.C.R. = Feed given / Animal weight gain

III. RESULTS AND DISCUSSIONS

3.1 Comparison of organic and inorganic content between species

The polychaete species studied showed an almost fixed range of variation in water and organic content. All polychaete species had water content near to 70% and all the species had organic content as much as 30% in their body mass. The highest water content was found to be in *Diopatra neapolitana*, as much as 71.38%. *Marphysa mossambica* comes next in terms of water content which had as much as 70.23%. The rest (*Halla parthenopeia*, *Perinereis quatrefagesi)* had less than 70% water content (69.07 and 68.25% respectively). The highest organic content from body mass was found to be from *Perinereis quatrefagesi*, as much as 31.75% (Figure 2). However, a similar study done on polychaete species gathered in Mediterranean sea by Moussa Dorgham et al. (2015) depicts that; the polychaete samples contained 85-87% of water and overall all samples examined had more than 80% water content on average. The lower water content found in the local samples compared to the Mediterranean sample were might be due to dehydration, as the Malaysian polychaete samples were collected during low tide. Whereas the Mediterranean samples were collected from the benthic region which was not exposed to low tides. Another study of similar stature by Varatharajan (2013) also illustrates that the polychaete samples collected off the coast of Tamilnadu, India contained more

than 80% of water. Unsurprisingly, these samples were also collected from the benthic region which is unexposed to low tides. Another study by Danovaro et al. (1999) who studied marine worms in the coastal region (subject to tidal inundations) suggests that the marine worms contained 76% of water similar to the results of the current study. In a study by Brown et al. (2011), tank cultured polychaete was discovered to have 79.8% water content.The proofs from the research suggest that the polychaete sample analysed in the current study contained lesser water content (68-71%) because of the effect of the low tide during sample collection.

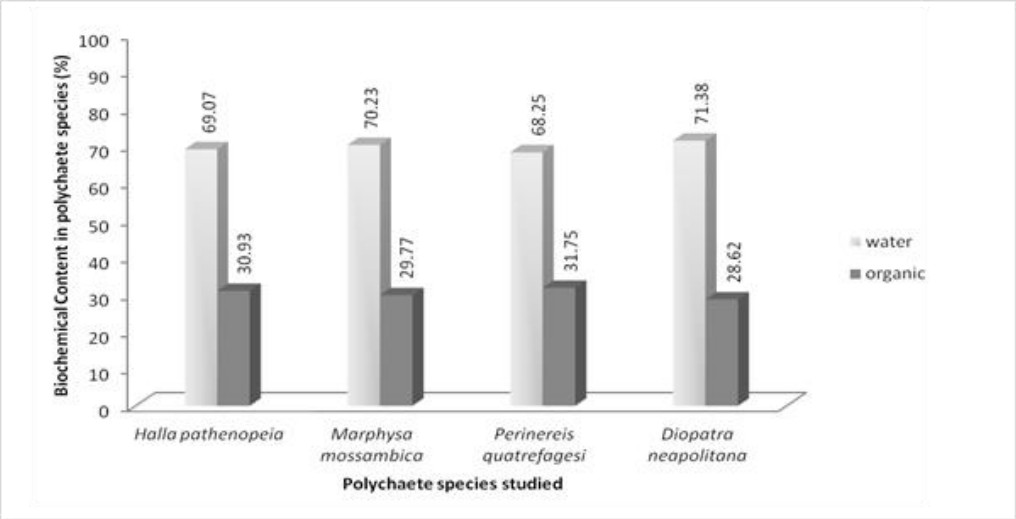

Fig.2: Comparison of water and organic content between the polychaete species Halla parthenopeia, Marphysa mossambica, Perinereis quatrefagesi, Diopatra neapolitana.

3.2 Proximate analysis of polychaete specimens collected at Port Dickson, Malaysia

Figure 3 illustrates the results of the proximate analysis of 4 polychaete specimen collected from Port Dickson, Malaysia. The result was discussed in the following sections 3.21- 3.24.

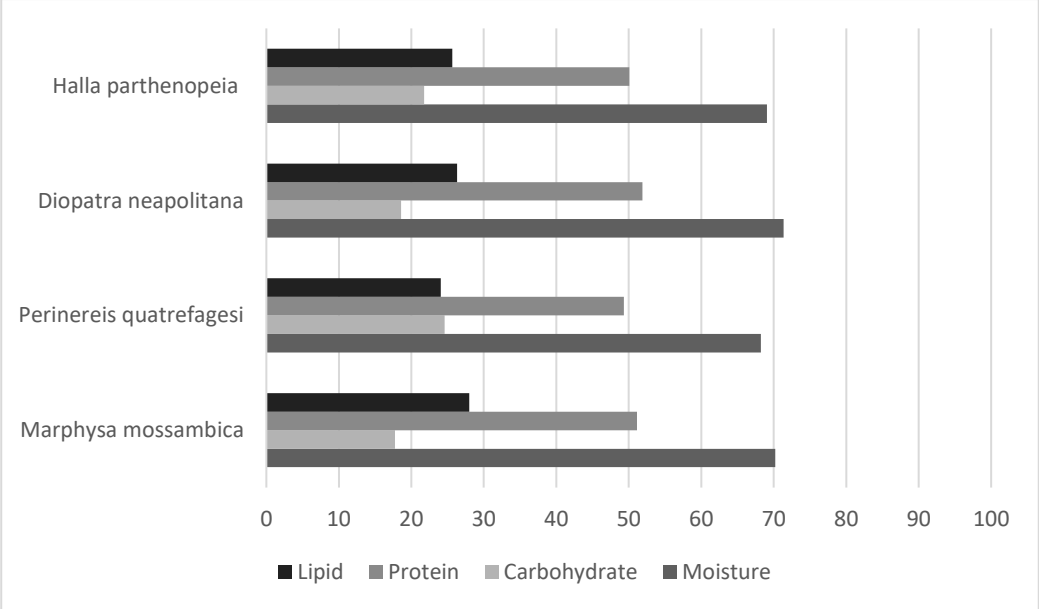

Fig.3: Proximate Analysis of Polychaete Specimens Collected from Port Dickson, Malaysia.

3.2.1 Lipid

Among the four species studied the highest lipid content by percentage found was in *Marphysa mossambica*. That

is as much as 27.98%. The lowest lipid content by percentage was found in species *Perinereis quatrefagesi*. That is as much as 24.08%. The percentage of lipid content of *Diopatra neapolitana* and *Halla parthenopeia* were 26.31% and 25.65% respectively. Yet the percentage of lipid content does not vary significantly. The lipid composition in percentage only varies by a range of ± 3.00 % between the different polychaete species (Figure 3).

3.2.2 Protein

Among the four species studied the highest protein content by percentage found was in *Diopatra neapolitana*. That is as much as 51.87%. The lowest protein content by percentage was found in species *Perinereis quatrefagesi*. That is as much as 49.32%. The percentage of protein content of *Marphysa mossambica* and *Halla parthenopeia* was 51.14% and 50.06% respectively. The protein content of *Marphysa mossambica* and *Halla parthenopeia* were relatively as high as the protein composition of *Diopatra neapolitana*. Yet the percentage of protein content does not vary significantly. The protein composition in percentage only varies by a range of ± 2.55 % between the different polychaete species (Figure 3).

3.2.3 Carbohydrate

Among the four species studied the highest carbohydrate content by percentage found was in *Perinereis quatrefagesi*. That is as much as 24.61%. The lowest carbohydrate content by percentage was found in species *Diopatra neapolitana* and *Marphysa mossambica*. That is as much as 18.58% and 17.76% respectively. The percentage of carbohydrate content of *Halla parthenopeia* was 21.76% which was the second-highest carbohydrate composition recorded. Yet the percentage of carbohydrate content does not vary significantly. The carbohydrate composition in percentage only varies by a range of ± 7.00 % between the different polychaete species (Figure 3).

3.2.4 Water

Among the four species studied the highest water content by percentage found was in *Diopatra neapolitana*. That is as much as 71.38%. The lowest water content by percentage was found in species *Perinereis quatrefagesi*. That is as much as 68.25%. The percentage of water content of *Marphysa mossambica* and *Halla parthenopeia*was 70.23% and 69.07% respectively. Yet the percentage of water content does not vary significantly. The water composition in percentage only varies by a range of ± 3.13 % between the different polychaete species (Figure 3). In an overall comparison of biochemical composition by percentage between all four species studied, it was known that the polychaete species *Marphysa mossambica* has the highest percentage of lipid as much as 27.98 % (Figure 3). *Diopatra Neapolitana* has the highest protein content in their body, as much as 51.87% and followed close by *Marphysa mossambica* as much as 51.14% respectively (Figure 7). The highest carbohydrate content was found in the polychaete species *Perinereis quatrefagesi*, as much as 24.61% (Figure 3). The highest ash content was found in *Diopatra neapolitana* yet *Marphysa mossambica* has comparatively high ash content as well as much as 3.12% compared to 3.24% in *Diopatra neapolitana* (Figure 3). Similar pattern as in ash content can be seen for water content as well. *Diopatra neapolitana* has the highest percentage of water that is much as 71.38% and followed closer by *Marphysa mossambica* with water content as much as 70.23% (Figure 3). In the overall view, both *Diopatra neapolitana* and *Marphysa mossambica* are the species with the highest biochemical composition compared to the other two species studied.

3.3 Comparison of biochemical composition within polychaete species

3.3.1 *Halla parthenopeia*

The dried organic portion of *Halla parthenopeia*from the current study revealed that the polychaete specimen contains 50.06% protein, 25.65% lipid, 21.76% carbohydrate followed by 2.53% of ash (Figure 4). In a study by Osman et al. (2010), on *Halla parthenopeia* it was discovered that the specimen gathered from Lake Timsah, Suez Canal had 51% protein, 25.88% lipid, 20.72% carbohydrate and 2.3 % ash content. Apart from the study by Osman et al. (2010), no other prominent study on *Halla parthenopeia* biochemical compositionwas found in the literature search. When comparing the polychaete specimen of Osman et al. (2010) and the current study, both had similar biochemical composition. However, the specimen from the Suez Canal had slightly higher protein and lipid content. Whereas, the specimen from port Dickson Malaysia had slightly higher carbohydrate content.

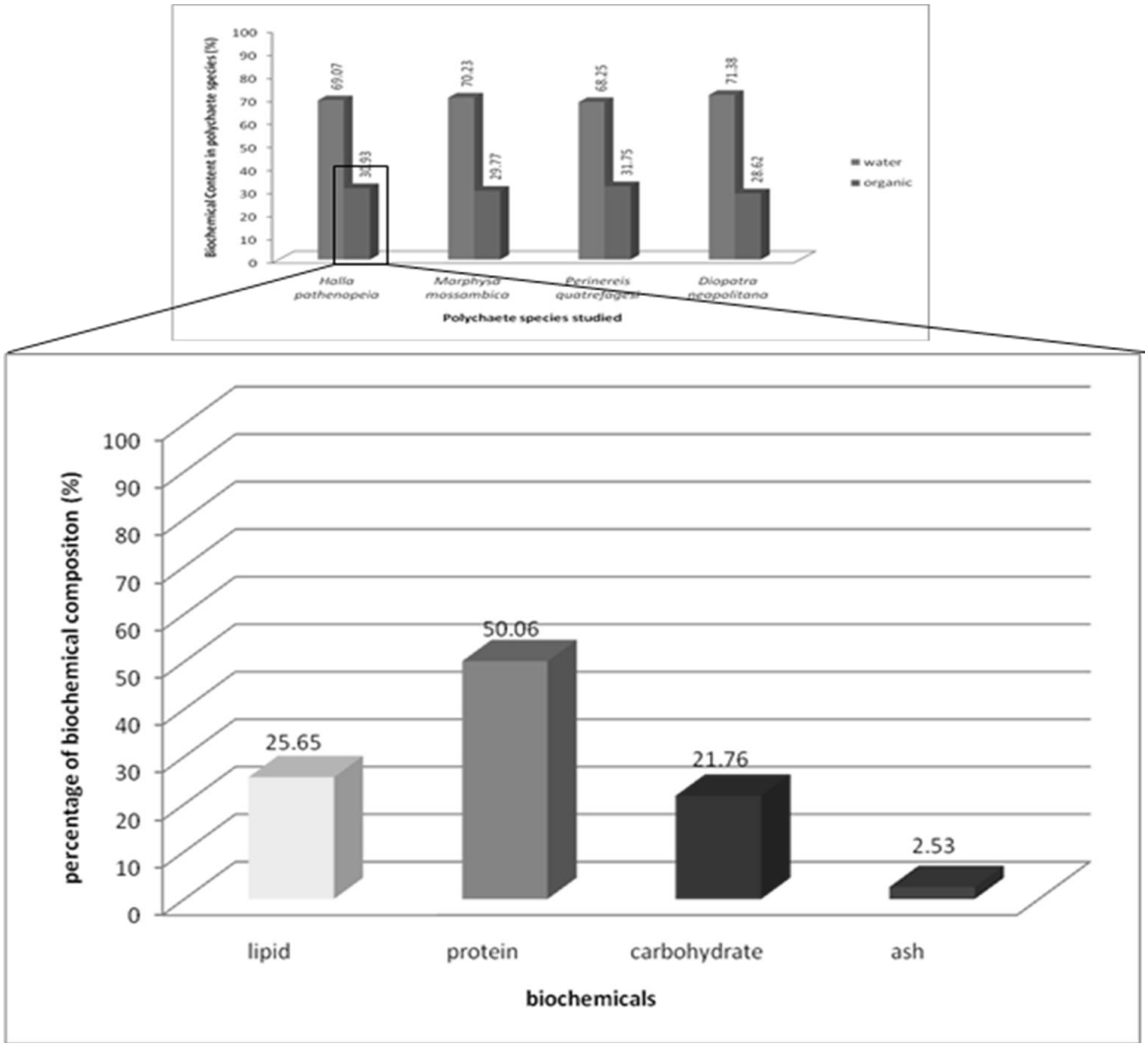

Fig.4: Comparison of organic content of the polychaete species Halla parthenopeia.

This fluctuation in the biochemical composition is insignificant.Moreover, it is subject to variation due to dietary options available in the region, also the growth stage (juvenile or adult) and not to forget that gender of the specimen was not considered in the comparison as well. That is because in research by Rodrigues et al. (2009) it was found that there was significant a difference in biochemical composition polychaete specimen of different gender and growth stage.

3.3.2 *Diopatra neapolitana*

From *Diopatra neapolitana* wet sample studied it was found that the polychaete contains, 71.38% of the water of its body mass. From the dried sample, it was known that the polychaete contains 49.32% protein, 24.08% lipid, 24.61% carbohydrate followed by 1.99% of ash (Figure 5).According to Carregosa et al. (2014) in the *Diopatra neapolitana* they collected there was approximately 21.0% of protein and 5.6% carbohydrate (glycogen). *Diopatra neapolitana* specimen in the study by Freitas et al. (2016) had 33.8% protein, and 0.9% carbohydrate (glycogen). In an earlier study,Freitas et al. (2015) reported that *Diopatra neapolitana* specimens had 12.0% of protein and 0.67% of carbohydrate (glycogen). In a subsequent study Freitas et al.(2015a) also found out that *Diopatra neapolitana* specimen collected from Rio di Aveiro, Portugal contains 14.7 % protein and 0.96% carbohydrate(glycogen). In a study by De Marchi et al. (2017), *Diopatra neapolitana* specimens had 12.0% of protein and 0.3% of carbohydrate (glycogen). The investigation by Pires et al. (2017) revealed that *Diopatra neapolitana* specimen collected from Rio di Aveiro, Portugal contains 11.3 % protein and 3.1% carbohydrate(glycogen). In their previous study,Pires et al. (2016) found out that *Diopatra neapolitana* specimen collected from Rio di Aveiro, Portugal contains 12.0 % protein and 0.8% carbohydrate(glycogen). When samples from other regions were compared to samples from Port Dickson, Malaysia, it indicates that the local samples have higher protein, lipid and carbohydrate content. However,

this comparison is not entirely equivalent because the methods of proximate analysis (Kjeldahl vs Biuret for protein analysis) used by the authors from other region differs from the current author. Moreover, the authors from other regions have made glycogen as a representation of carbohydrate content in their *Diopatra neapolitana* specimen. Whereas, the current author has not used glycogen specifically as a representation of carbohydrate.

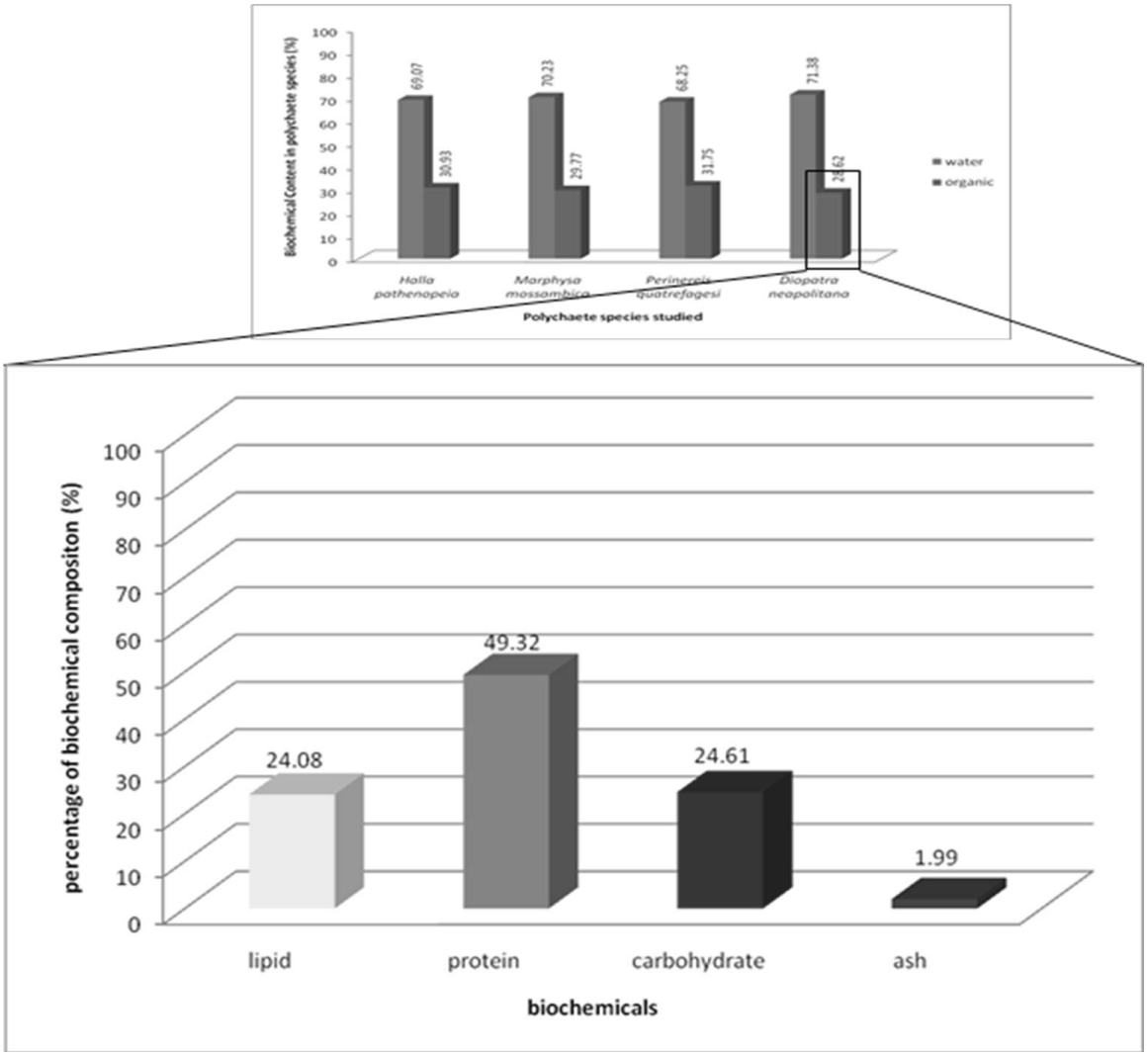

Fig.5: Comparison of organic content of the polychaete species Diopatra neapolitana.

3.3.3 *Marphysa mossambica*

From *Marphysa mossambica* wet sample studied it was found that the polychaete contains 70.23% of the water of its body mass. From the dried sample, it was known that the polychaete contains 51.14% protein, 27.98% lipid, 17.76% carbohydrate followed by 3.12% of ash (Figure 6). The *Marphysa mossambica* specimen bred as mud crab feed by Alava et al. (2017) found out that it contains 66% protein and 12 % lipid. The polycahete sample in the study by Alava et al. (2017) illustrates that it contains more protein than specimen from the current study. However, the polychaete specimen in the current study contains more lipid than specimens collected by Alava et al. (2017). This difference in protein and lipid level could be because the specimen from the current study was collected from wild and the specimen from the study by Alava et al. (2017) was cultured and bred in captivity. Thus that could be because the specimen in captivity might be fed with formulated feed to maintain quality for its latter use as mud crab feed. In a previous study by Matanda R., (2014) the *Marphysa mossambica* samples from Kenya contained 53.7 % protein, 6.6% lipid, 4.9% carbohydrate and 26.2 % ash. This data proves that there is an inconsistency in the organic composition of the polychaete *Marphysa mossambica*.

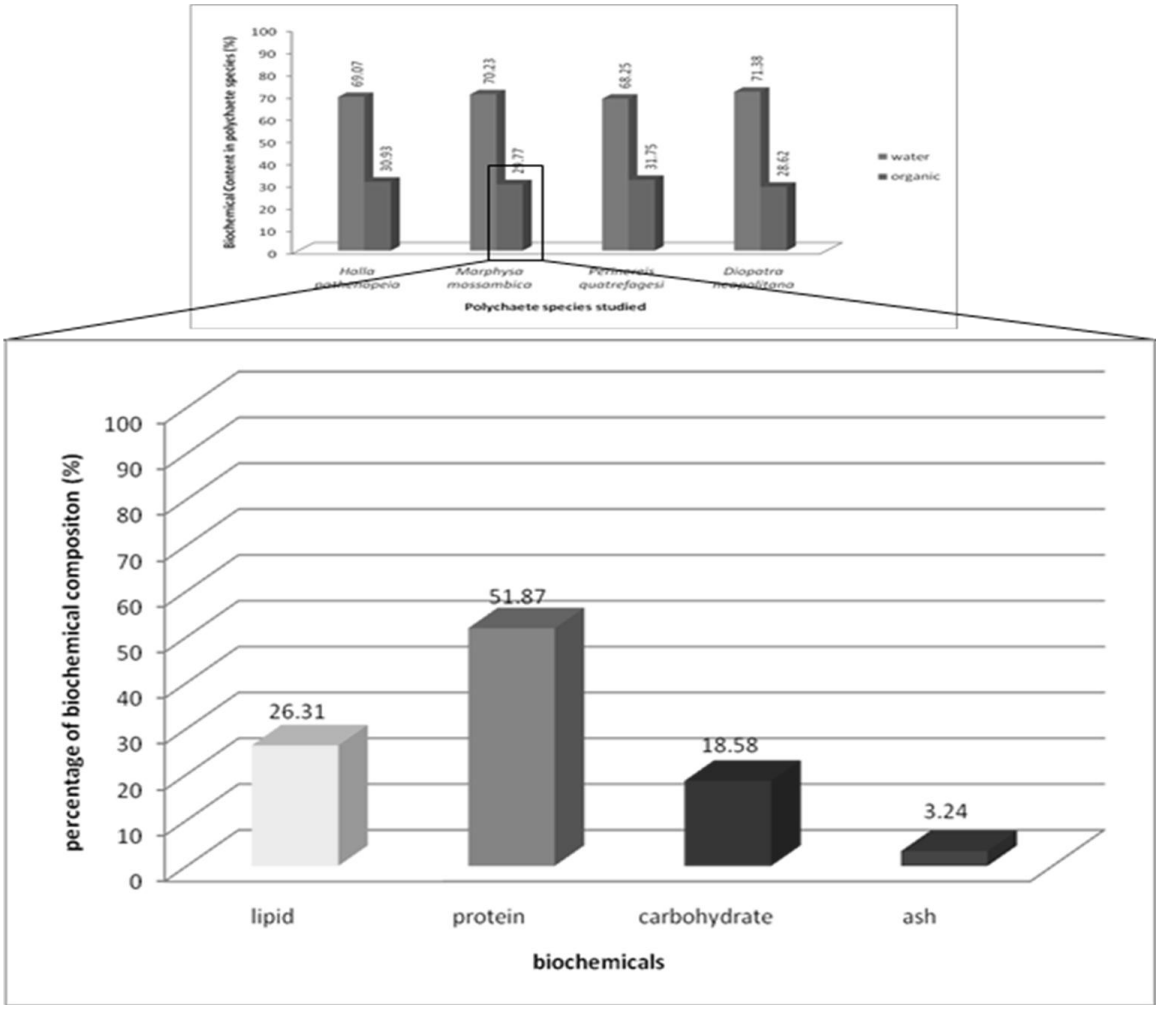

Fig.6: Comparison of organic content of the polychaete species Marphysa mossambica.

3.3.4 *Perinereis quatrefagesi*

From *Perinereis quatrafagesi* wet sample studied it was found that the polychaete contains 68.25% of the water of its body mass. From the dried sample, it was known that the polychaete contains 49.32% protein, 24.08% lipid, 24.61% carbohydrate followed by 1.99% of ash. Only in this polychaete species, the lipid % seem to be almost equivalent to carbohydrate % but in other species, the lipid % exceeds carbohydrate % (Figure 7).Perinereis quatrafagesi specimen collected from the coastal sandy shores of Guimbal, Iloilo, Philippines contained 57% protein, and 18.9% lipid [29]. Previous studies conducted on *Perinereis quatrafagesi* specimen from the same region also showed that it contained 53% protein and 16% lipid (SEAFDEC, 2011). Apart from the literature from SEAFDEC no other accordant research publication was found on *Perinereis quatrafagesi*. However, there are publications focused on a similar aspect of current research on other species of the same genus. In a study by Elayaraja et al. (2011) on *Perinereis cultrifera* specimen, the proximate analysis revealed that it contained 5.64% protein, 1.31% lipid, 1.02% carbohydrate and 7.82% moisture content. Another study by Lv et al. (2017) reported that *Perinereis aibuhitensis* specimen contained 60.9% protein, 10.1% lipid, and 84.3% moisture. The *Perinereis quatrafagesi* specimen from the current study containedlesser protein and lipid content because it was collected from the wild and the specimen from other studies and species were cultured with formulated feed or a controlled diet. The readily available food source must have made them have higher protein and lipid content.

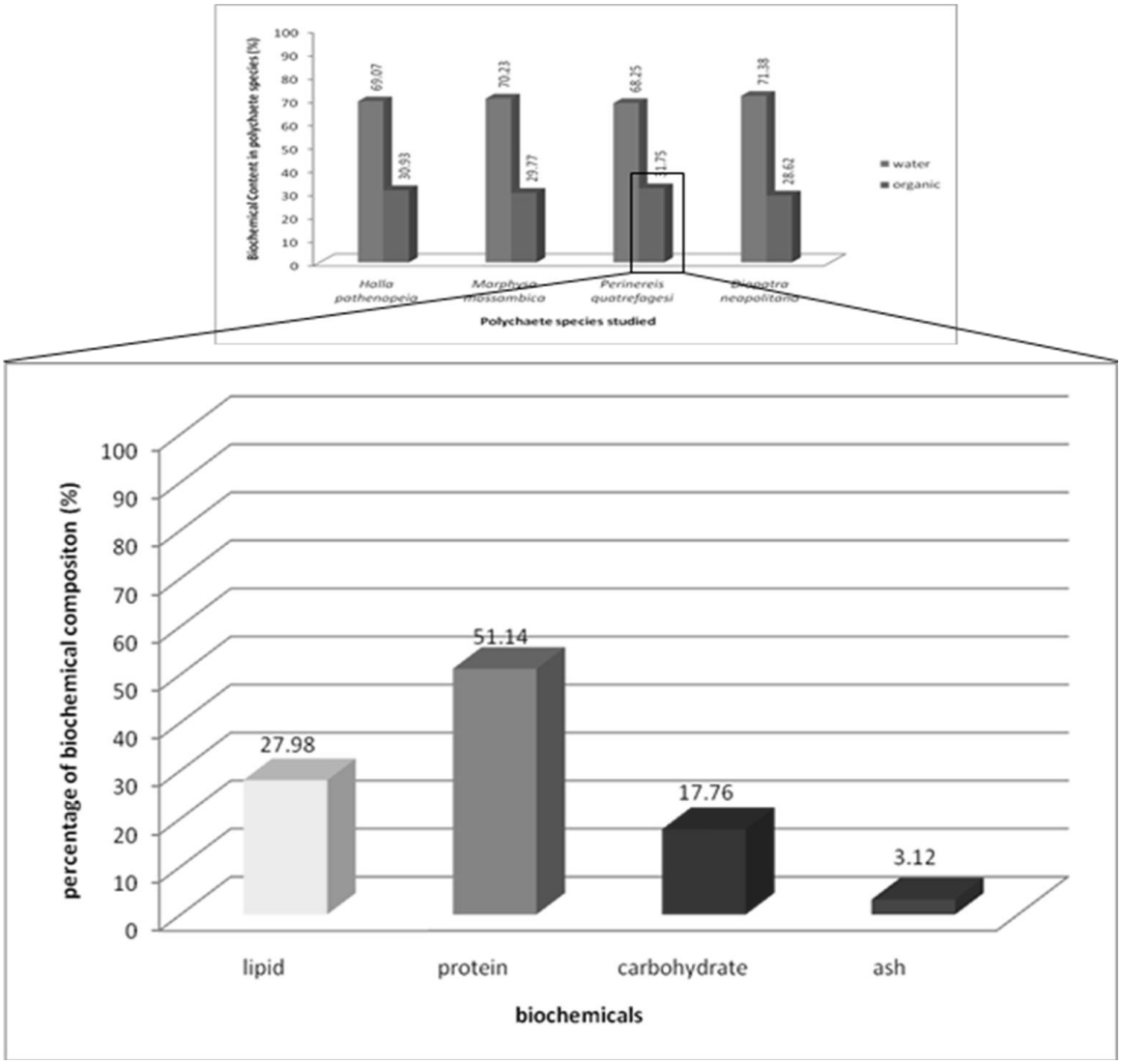

Fig.7: Comparison of organic content of the polychaete species Perinereis quatrefagesi.

3.4 Comparison of the biochemical composition of polychaete with commercial fish meals

In comparison with the biochemical composition of polychaetes obtained from the study, it shows that all the polychaete species has higher protein content compared (Table 1) to soya fish meal although the rest of artificial formulated feeds have higher protein content compared to the polychaete species. All the polychaete species studied had higher lipid content higher than any artificial formulated feed. That is up to 20-10% more lipid. From Figure 8 it's evident that the polychaete specimens from Port Dickson, Malaysia has the potential to be developed as aquaculture feed. Because they possess a fairly comparable amount of protein which is the most important part of an aquaculture feed. Besides that, the polychaete specimens also contain higher lipid content compared any formulated feed. Figure 8 also illustrates that all the polychaete are more suitable to be used as life fish feed compared to the artificial feed. Growth rate and maximum lifespan have to be considered for commercial feed culture activities. Polychaetes can be an alternative to fish meal for the protein component in artificial fish feeds. More promisingly it can be used directly as life aquaculture feed compared to pellet feed. Using life feeds can improve the health and growth rate of cultured organisms [33]. Polychaetes improved the breeding performance of some shrimp and fish species[34]. In the case of*Penaeus monodon* (shrimp) where spawning frequency reached 85% when fed with 16.5% worm diet and only 57% when given feeds with only 8% worm diet[29]. However, the live feed practice also comes with a disadvantage where the feed organism can be a vector to diseases amongst cultured organism; for example the spread of White Spot Syndrome Virus (WSSV) disease amongst shrimp [35]. Therefore, the real challenge in implementing this would be, culturing the polychaete which is free from any diseases.

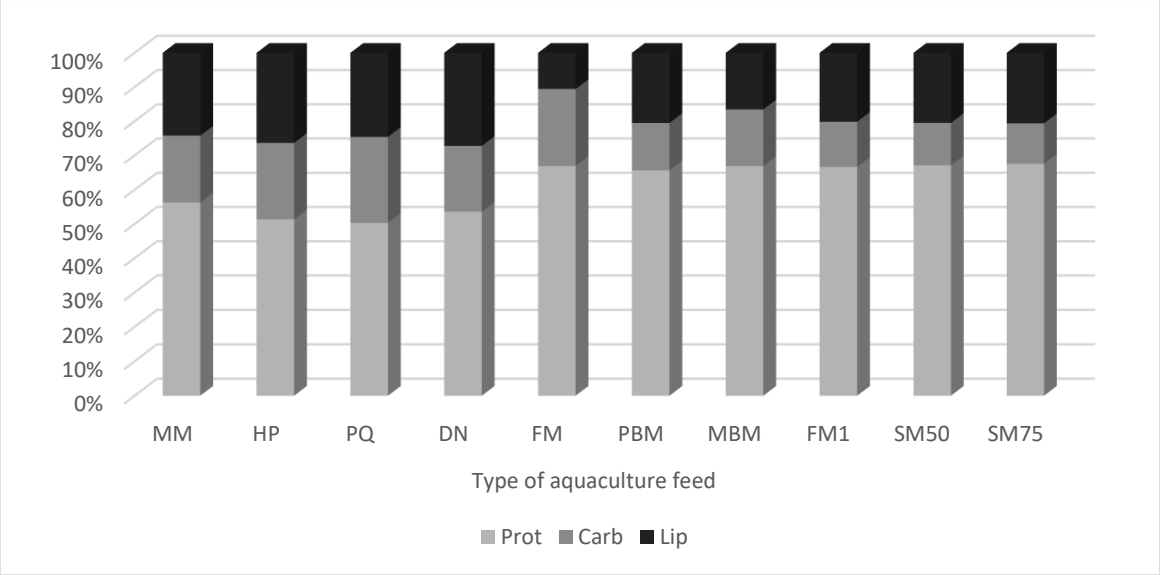

Fig.8: Comparison of protein, carbohydrate, and lipid (Prot, Carb, and Lip) content of the polychaete specimens from Port Dickson, Malaysia with formulated feeds.

PA (%) - Proximate analysis in percentage
MM, HP, PQ, DN - *Marphysa mossambica* (MM), *Halla parthenopeia* (HP), *Perinereis quatrefagesi* (PQ), *Diopatra neapolitana* (DN) (polychaete from Port Dickson, Malaysia)
FM, PBM, MBM - White Fish Meal (FM), Poultry by product Meal (PBM), Meat and Bone Meal (MBM) [40].
FM_1, SM50, SM75 - Fish Meal (FM_1), Soy meal 50% + Fish Meal 50% (SM50), Soy Meal 75% + Fish Meal 25% (SM75)[41]

Table 1 Comparison of protein, carbohydrate, and lipid (Prot, Carb, and Lip) content of polychaete specimens from Port Dickson, Malaysia with formulated feeds.

	Type of aquaculture feed									
	MM	**HP**	**PQ**	**DN**	**FM**	**PBM**	**MBM**	**FM_1**	**SM50**	**SM75**
PA (%)										
Prot	51.14	50.06	49.32	51.87	63.65	60.84	55.02	42.63	43.24	43.04
Carb	17.76	21.76	24.61	18.58	21.42	12.82	13.60	8.43	7.98	7.53
Lip	21.98	25.65	24.08	26.31	10.06	18.99	13.60	12.88	13.19	13.12

3.5 Growth performance of Tilapia fish on different diets

Tilapias fed with polychaete *Diopatra neapolitana* (live feed) experienceda significantly higher WG (Figure 9), SGR (Figure 10) and FCR (Figure 11) throughout the experiment when compared with Tilapias fed with pellet food. That could due to the lower protein composition found *Diopatra neapolitana* compared to the pellet feed (Figure 8). Study by Kabir et al.(2019) shows that Tilapias fed with low protein meals attained better WG and SGR compared to Tilapias fed with high protein meal. Apart from that, the better growth performance of Tilapia on polychaete diets were also believed to be from higher fatty acid content (Figure 8). Research by Grayson and Dabrowski(2020) rainbow trout that were fed with feed higher in fatty acid content achieves achieved enhanced growth performances. Another study by Parma et al (2020) on feeding gilthead sea bream with feed high in fatty acids showed significant increase in growth performance. The abundance of micronutrients present in live feed meals are also an important factor which contributes to increased growth performance of aquaculture species. This was evident in the results of feeding Atlantic Salmons with soldier fly larvae meals [39].

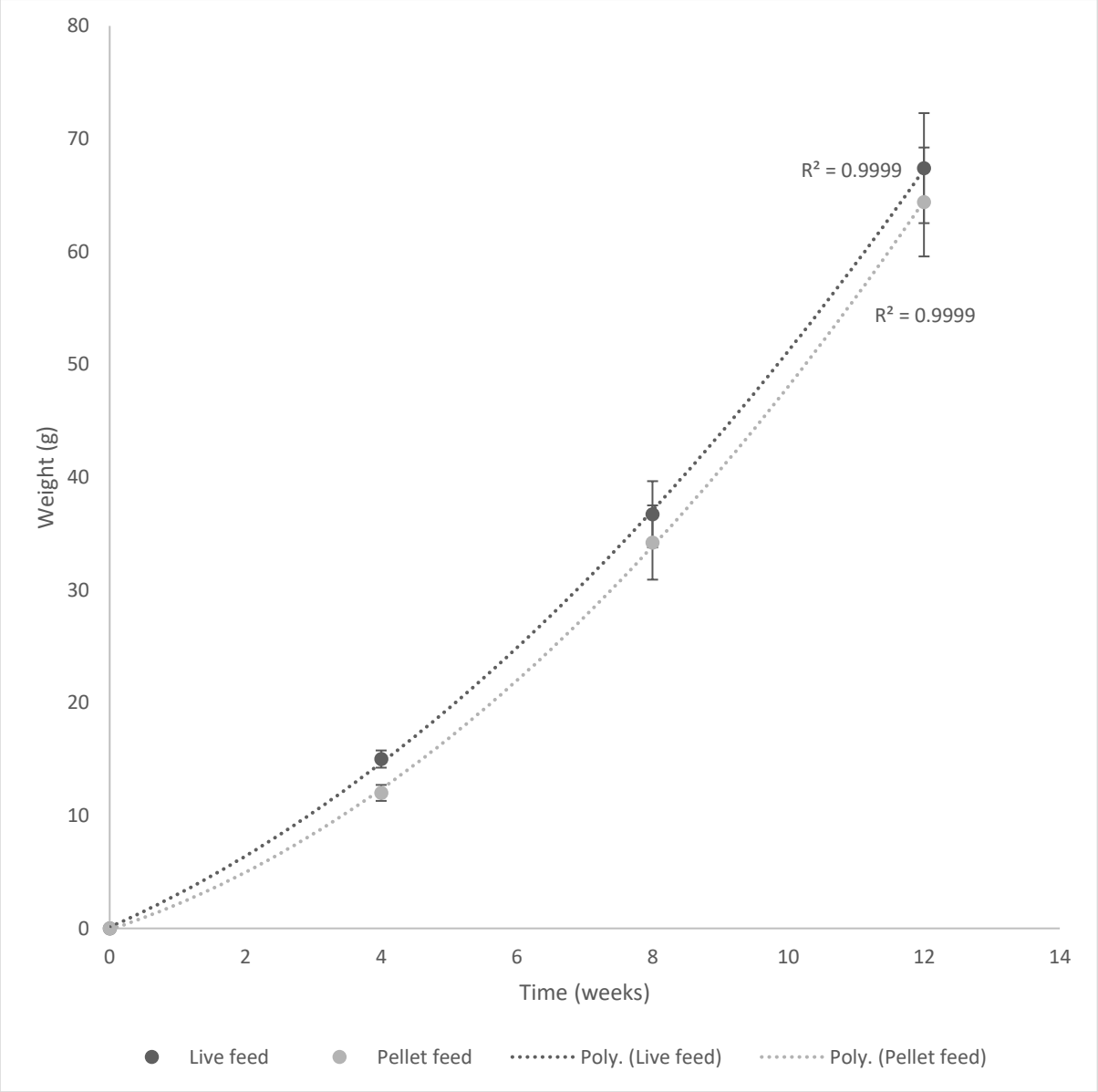

Fig.9: Weight gain of Tilapia fed with live and pellet feed

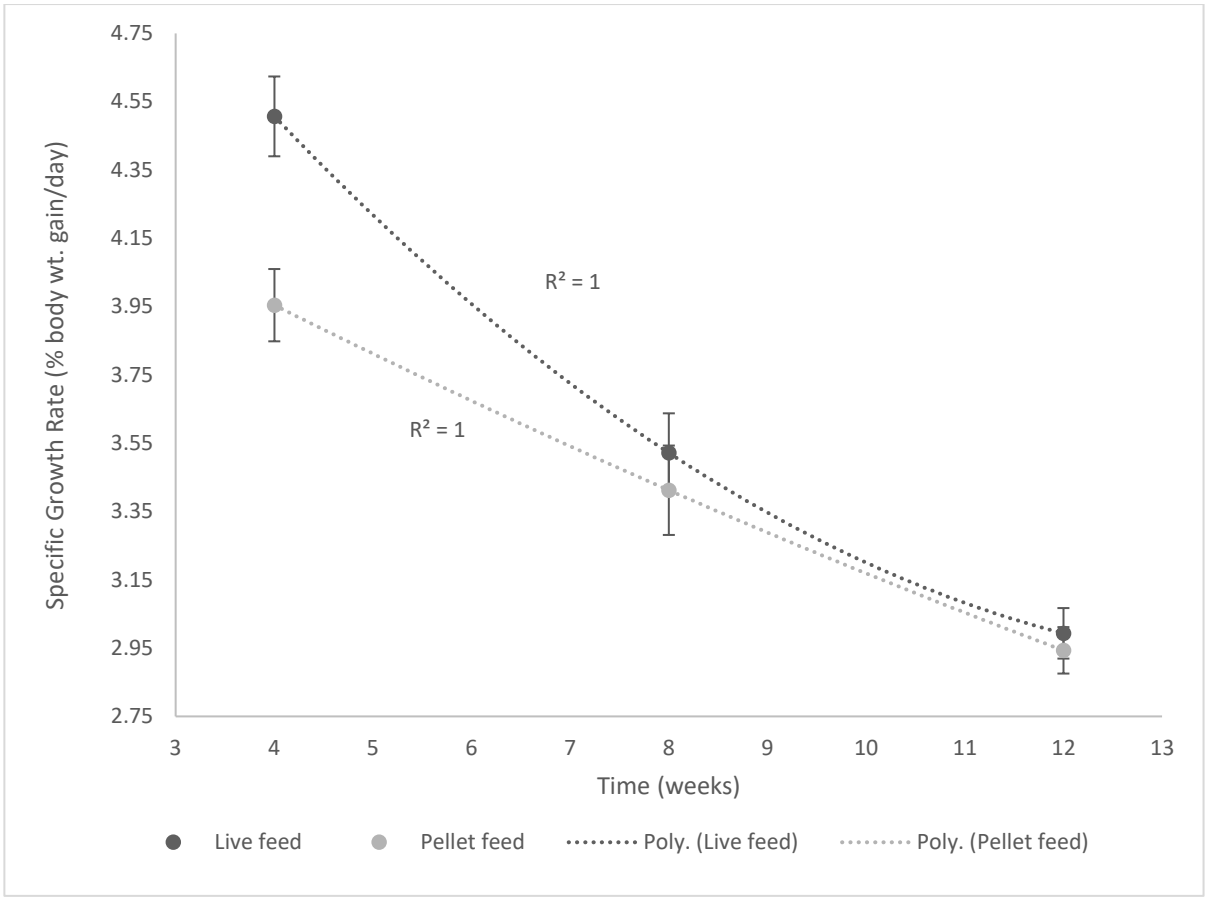

Fig.10: Specific Growth Rate (SGR) in Tilapia fed with live and pellet feed

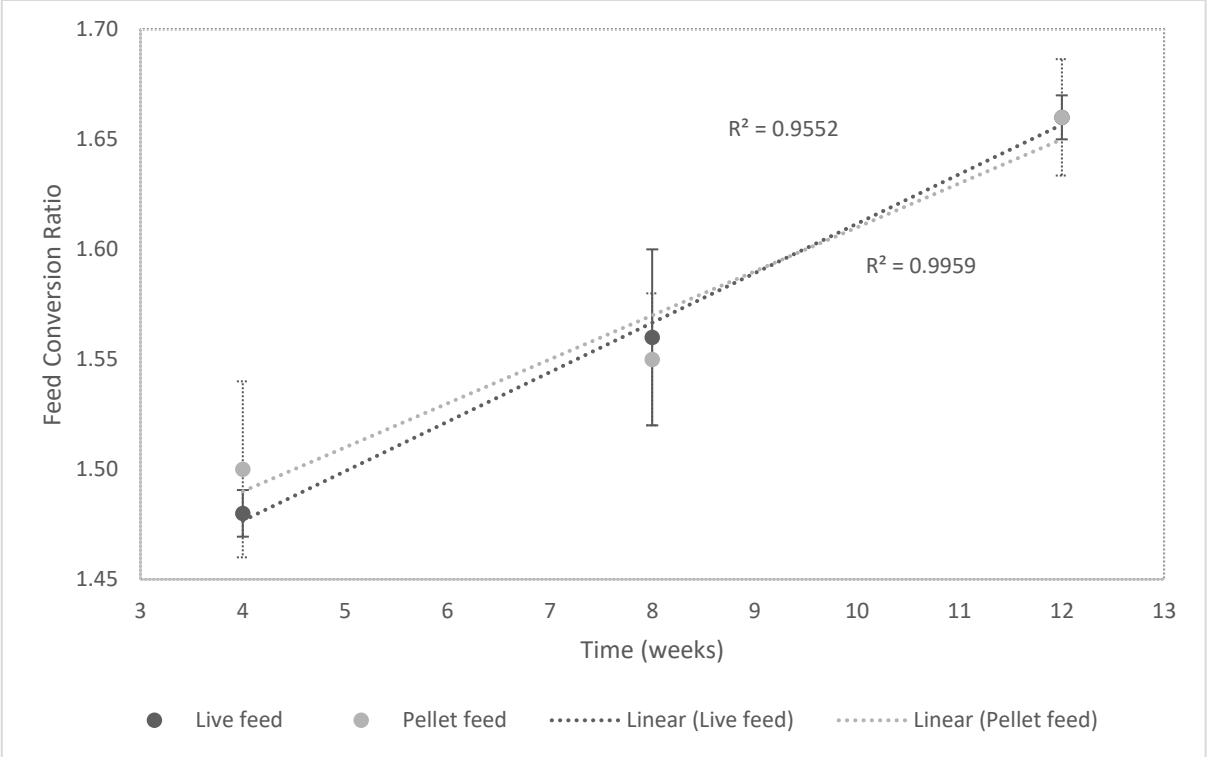

Fig.11: Feed conversion ratio of Tilapia fed with live and pellet feed

IV. CONCLUSIONS

Four species of polychaetes were obtained from Port Dickson, Negeri Sembilan region and studied. The polychaete species were *Diopatra neapolitana, Perinereis quatrefagesi, Marphysa mossambica, and Halla parthenopeia*. All the polychaete species were subjected to various biochemical composition analyses for the biochemical composition of lipid, protein, carbohydrate, water and ash. The biochemical composition within species also shows a constant composition even though it varies in terms of value. Water is the most abundant in all species of polychaete studied and followed by protein, lipid, carbohydrate and ash respectively. From the results, it can be concluded that all the polychaete species studied would be suitable to be used as live feed organism for culture fisheries. That is because in comparison with commercial artificial fish feed the polychaetes have higher biochemical composition. This conclusion was made based on the biochemical composition.

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