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Suitability of Polychaete Worms (Marphysa Mossambica) as Protein and Lipids Ingredient for the Culture of Tiger Prawn (Penaeus Monodon) in Hapa Nets in Tidal Ponds of Mtwapa Creek

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Abstract

This study presents an evaluation of cultured polychaetes (Marphysa Mosambicca sp.) as a suitable protein and lipid source alternative to freshwater shrimp in the feed formulation of Tiger prawn (Penaeus monodon) Juveniles. The study was conducted over 94-day period using twelve hapa nets of 1m3 each installed in a tidal pond measuring 0.08 ha at Kwetu training centre farm. Each hapa was stocked at a density of 20 juveniles/m3 of P. monodon collected within Mtwapa creek. The initial weight and length were recorded before stocking, averaging at 1.28+0.84 grams and 5.26±0.68 cm. Polychaete worms (Marphysa mossambica) were cultured at Kwetu Training Centre mariculture systems, and used for preparation of formulated feeds. Three polychaete substitution diets were formulated with varying contents of polychaetes as follows; Poly-30%, Poly-35% and Poly-40%. The commercial shrimp meal with no polychaete added (0%) was used as a control diet. The four diets were administered to the juveniles @3% body weight for the experiments: (Control (poly 0%), Poly-30%, Poly-35% and Poly-40%). Each diet formulation was randomly allocated to three (3) three treatments, with Control (Poly-0) allocated to Hapa net No. 2, No.7 and No.8), Poly-30% to Hapa No.4, No.5 and No.9), Poly-35% (No.10, No.11 and No.12), and Poly-40% (Hapa 1, 3 & 6). The shrimps were acclimatized for four (4) weeks and thereafter, length and weight sampling to monitor growth, conducted fortnightly. Results showed significant differences in growth rate among the treatments/diets (Weight (g), F=10.23, P<0.05, Specific growth rate SGR, F=11.99, P<0.05, and exposure periods (Weight WG, F=34.17; SGR, F=122.49). The highest weight gain (2.71 g) and SGRs (5.74 % /day) were recorded on Poly-40% and Poly-35% diet treatments, which were significantly higher than both the shrimp meal and poly-30% diets. The Poly-30% diet had a lower SGR (3.50%/day), but weight gain was comparable to the shrimp meal control diet treatments. Limited quantities of cultured polychaetas and drying methodology for the polychaetes limited 100% polychaete substitution. The results of this study provide a basis for the integration of Marphysa mossambica in the formulation of diets for Tiger prawn. Refining culture protocols for Marphysa mossambica require further investigation.

Keywords: Black Tiger Prawn, Aquaculture, Growth Performance, Water Quality, Feed Efficiency, Sustainable Aquaculture, Marine Biology, Shrimp Farming, Hatchery Techniques, Aquatic Ecology, Fisheries Science, Climate Change and Aquaculture, Molecular Genetics in Aquaculture

Introduction

Globally, the rapidly growing shrimp demand (~6% annually), is dominated by Asian intensive mariculture enterprise, while African participation remains minuscule [1]. The East African coastal prawn mariculture potential is well recognized, but currently, only a small selection of group-owned, government, and NGO-supported, pond polycultures, have been established along Coastal Kenya [2, 3]. Nevertheless, despite earlier, prawn culture demonstration at Ngomeni (Kenya), yielding 426 kg.ha-1, most subsequent startups, either collapsed or reported dwindling yields (< 180 kg.ha-1) [4, 5]. Low performance is attributed to the adoption of earthen ponds, limited feed supplementation, and poor technological adoption [2], in contrast to intensive systems elsewhere [6].

The Black Tiger Prawn (subsequently reported as BTP); Penaeus monodon (Fabricius, 1798), is the choice culture taxa, due to superior growth (0.7g.d-1) and hardiness, but also higher profitability, than either finfish or crab [3, 16]. BTP yields range from below 500 kg.ha-1 in extensive earthen ponds to over 5,000 kg.ha-1, in intensive systems that incur higher production cost (<10,000 $.ha-1) [3]. Floating cage cultures are currently encouraged, not only due to higher yields, but also lower maintenance and environmental impacts [7]. In Africa, uptake of cage culture has emerged in inland freshwater lake and pond fish aquaculture with yields of up to 14 kg.m-3, but marine cage culture lags [8]. Sea pen prawn culture is adopted in Asia with reported yields of up to 6.7 kg.m-3 (eg Maheswarudu et al, 2016) and requires investigation under local conditions.

Prawn mariculture, high nutritional dietary demands (e.g. Meunpol et al., 2005), impact sustainability, since feed sources are either expensive (e.g. animal protein), unsuitable (e.g. plant proteins) or compete with domestic livestock and human food demand [9]. In addition, BTP require feeds rich in polyunsaturated fatty acids (PUFA), such as linoleic acid and linolenic acid, and highly unsaturated fatty acids (HUFA) such as eicosapentaenoic acid and docosahexaenoic acid for faster growth (Kanazawa et al., 1979) [10]. Currently, Kenyan and other less developed nation feeds, are sourced from relatively cheaper starchy; maize germ, wheat pollard, among others, and animal protein; freshwater cyprinid Rastrineobola argentea (Omena, mukene) and Atyid shrimp; Caridina nilotica (Ochunga) (Munguti et al) [8]. However, these feed ingredients have huge competing human and livestock feed demands, thus threatening local food security and profitability. They are also deficient in essential nutrients, and frequently contain impurities (e.g. aflatoxins), injurious to prawns' health and performance. Freshwater Cyprinid (omena) and atyid shrimp (Subsequently designated 'Ochunga'), obtained from lake fisheries and widely used human and livestock feed ingredients, precipitate unsustainable fisheries but may also introduce problems of pest introduction and trophic inefficiency in prawn cultures. Nevertheless, a number of locally available feeds (eg Aqualife, Kamuthanga, Kegati pellets, Tigoi, among others) are formulated using these ingredients and touted as either high protein or ideal mariculture feeds. These feeds require further investigation to guide the search for sustainable local alternative aquaculture feeds in general and mariculture in particular.

Among alternative animal protein sources, culturable invertebrates such as earthworms and polychaete have received attention. Marine polychaetes are prime wild prawn dietary items, widely exploited as tropical fishing bait (e.g. Muthumbi et al, in press), and also as aquaculture feeds elsewhere (Olive 1999; Garcia-Alonso et al, 2008) [11], . Polychaete-based meals are rich in proteins and neutral and long-chain polyunsaturated fatty acids, critical to prawn growth (Murugesan et al, 2011) and spawning [12, 13]. The potential of polychaete-based meals for black tiger pawn culture is huge. This study evaluates a selection of feed ingredients content, formulated on an ochunga-based control diet whose content is compared with commercially available feeds. The control diet and formulated meals incorporating cultured and wild Eunicid polychaete (Marphysa mossambica), in cage cultures and BTP performance and yield compared.

Materials and Methods

Study Area

The study was carried out at the Kwetu training Centre (03056'S; 04042E), located approximately 6 km West of Mtwapa town, Kilifi County, and about 20 km north of Mombasa city center. The Kwetu Training centre borders Mtwapa creek which has eight of the nine mangrove species of the East African Coast dominated by Rhizophora mucronata. The area has a mean annual rainfall of 1200 mm and a temperature of between 200C to 350C.

One of the six production ponds (26×30m) at the Kwetu training centre was assigned for this study. The pond was repaired and cleaned to ensure a water depth of 1m and embankments strengthened. A boardwalk feeding platform and hapa net supports were constructed using wooden poles and planks. 12 hapa net enclosures of 1m3, were constructed using netting material (SH OPTNET; 50 mesh) and fastened to poles inside the pond. Ponds were drained, limed and chicken manure applied at a rate of 100g.m-2 and filled with tidal water during springtide in March 2017, in readiness for stoking with juvenile prawns.

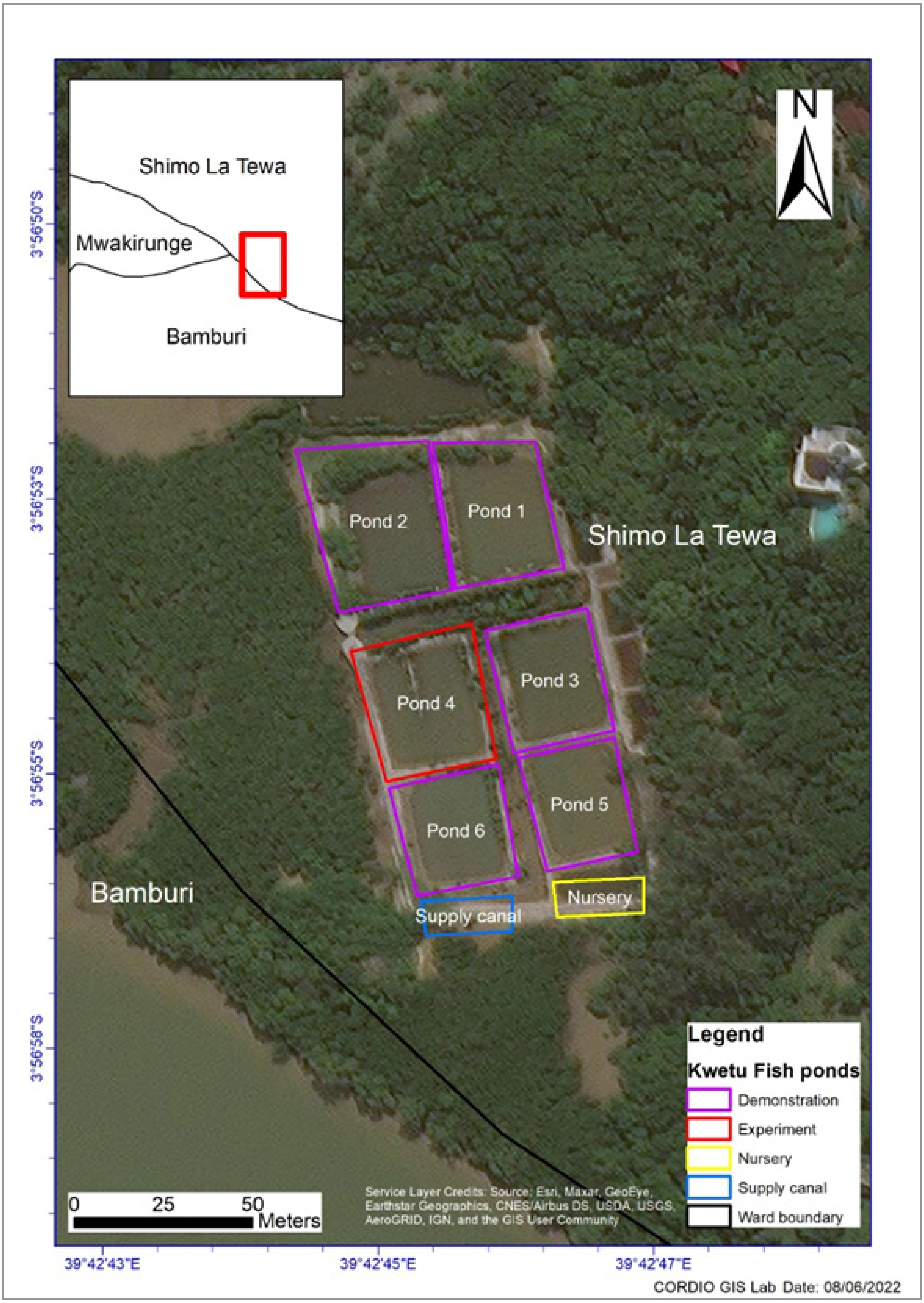

Figure 1: Map of Mtwapa Creek Showing the Study Site

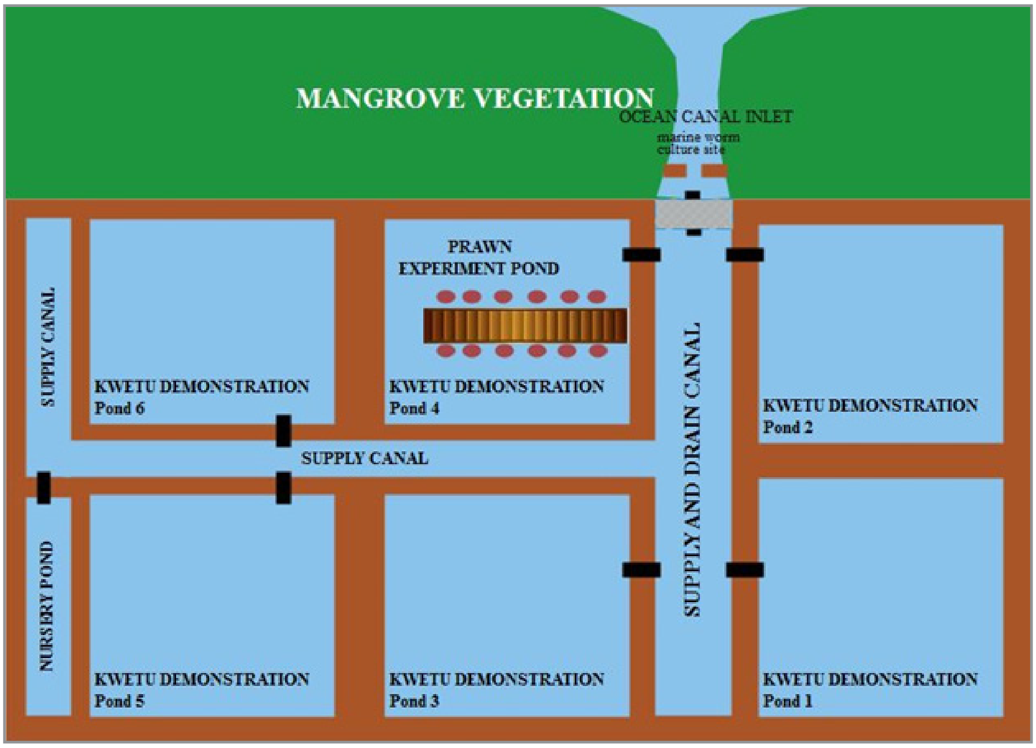

Figure 2: Pond Design Showing the Experimental Pond

Proximate Analysis
Proximate analyses were carried out at Egerton University, Biological Science laboratory. During the process, chemical tests were carried out to determine the moisture, crude protein, lipid, crude fiber and ash content. Unless otherwise indicated, standard AOAC protocols were used in determining crude carbohydrate, protein, lipid, fiber, moisture, and ash contents of known quantities of the test substance.

Crude Protein
Standard Kjeldahl digestion protocols involving digestion using concentrated sulphuric acid, neutralization with Sodium Hydroxide, and trapped Boric acid subsequent to titration with Hydrochloric acid were performed. Crude protein content was thereafter calculated as in Balthrop et al, 2011 and conversion factor of 6.25.

Crude Lipids
Soxhlet solvent extraction protocol involving ether extraction, preceding homogenization, and evaporation were adopted. Approximately 2g of feed sample was weighed into an extraction thimble and covered with a fat-free cotton wool. The extraction thimble was transferred into an extractor. Dried conical flask was weighed (W1) and 95ml of petroleum ether added. The extractor was then connected to the conical flask after which heating started. Crude fats in the sample were extracted for 6 hours. The solvent was distilled until the flask was nearly free from the solvent. The flask was left in a fume hood overnight to evaporate all the solvent. The flask with residue was dried for 1.5 hours, cooled and re-weighed (W2). The percentage Crude Fat was calculated using equation 5 (AOAC, 2012).

$\%\ \text{crude fat}=(W2-W1)/Wf\times100$

Where: Wf is the weight of the feed used (g), W1 is the weight of flask (g), and W2 is the weight of flask and fat residue (g).

Dry Matter (DM) and Moisture Content in the Feed Ingredients
Dry Matter (DM) and moisture content was determined using the drying method described by the Association of Official Analytical Chemists, AOAC (2012). A cleaned crucible was dried for one hour in an oven previously heated to 105 ˚C and later allowed to cool in a desiccator. The crucible was weighed (W1) and approximately 2g of the ground feed sample was added. The crucible containing the feed sample was oven dried for 2 hours at 105 ˚C followed by cooling in a desiccator. The sample was reweighed to determine the final weight (W2). The DM and moisture content in the sample was calculated according to AOAC (2012) formulae.

$\%DM=((W2-W1))/Wf\times100$ (1)

Where, W1 is the weight of empty dish (g), W2 is the weight of dish and feed sample after drying (g) and Wf is the weight of the feed used in grams.

$\%\ \text{Moisture}=100-\%\ DM$

Shrimp Feed Formulation Using the Pearson Square Method
Feed ingredients: Ochunga, cotton seed cake, maize germ, soybean, sunflower seed cake, cassava fish oils, and vitamin premix were obtained from local shops and markets where appropriate. Ingredients were cleaned to remove the stone and other impuri-

ties, dried to constant weight and ground to fine powder, where appropriate. Shrimp feed formulation was carried out using the Pearson Square Method [14].

Cultured polychaetes (Marphysa mossambica) for feed formulation were obtained from the culture facility at Kwetu Training Centre. The worms were dried to constant weight and ground and substituted with 9, 18 and 26% of aqualife shrimp meal and mixed thoroughly. The commercial aqua life shrimp meal with no polychaete added was used as a control diet. The three polychaete substitution diets were formulated with varying contents of polychaetes as follows; Poly-30, Poly-35 and Poly-40. The diets were prepared monthly mixed and appropriately stored them for subsequent trial. Protein, lipid and fibre content of each meal was estimated using standard protocols (Table 1).

Feed type	Crude Protein (%)	Crude Lipid (%)	Crude Fibre (%)
Shrimp meal	24.7	3.67	22.41
Poly-9	29.9	4.15	22.79
Poly-18	35.2	4.63	23.15
Poly-26	40.0	5.06	23.48

Juvenile BT Prawn Stocking into Hapa Nets at Mtwapa Creek
Juveniles of giant tiger prawn were obtained from Mtwapa creek during low tide of springtide from in February 2017. Harvested juvenile tiger prawns were sorted to exclude untargeted species transported and introduced into 2 hapa nets. From these storage nets, 20 individual each weighing about 1.28+0.84 g were introduced into the 12 test nets. Initial average weight and length of individuals introduced into each hapa net, was recorded.

Each diet formulation was randomly allocated to 3 Hapa nets; Poly- 0% (control) (Hapa 2, 7 & 8), Poly- 30% (Hapa 4, 5 & 9), Poly-35% (10, 11 & 12), and Poly-40% (Hapa 1, 3 & 6). After an initial four-week acclimation, all prawns in the hapa nets were obtained fortnightly, using a scoop net, and their weights and length determined, and returned to their respective nets. The total length was measured using 30cm ruler, while the weights, using an electronic scale. Feeding was done twice daily (9.00 am and 5:00 pm), at a rate of 3% body weight of prawns, determined fortnightly and the amount of feed to be administered was adjusted accordingly after every sampling.

Determination of BT Prawn Performance in Hapa Nets
Data obtained on shrimp wet weight for each replicate were used in calculating growth parameters; Absolute Growth rate (AGR), Biomass Weight Increase (BWI) and Specific Growth rate (SGR) using the following formulae;

$$K = \frac{W_f}{L_f^3} \times 100$$

$$AGR_i = \frac{W_f - W_i}{t}$$

$$BWI_i = \frac{W_{fi} - W_i}{W_{fi}} \times 100$$

$$SGR_i = \frac{lnW_{fi} - lnW_i}{t} \times 100$$

Where: K-Foulton condition factor, Wf-Final weight, Lf-Final length, Wi- mean initial weight, Wfi-stage specific final weight, t- exposure period (days).

Prawn survival rates were determined from enumeration of number of prawns in each replica and survival calculated using the following formulae (Busacker et al., 1990);

$$SR\% = \frac{N_t}{N_0} * 100$$

Where: Nt- number at time t, No-number at start of stage.

Data on food administered and weight gains were used to compute Food Conversion Ratio (FCR), using the following formulae;

$$C = W_{t-1} \times 0.03 \times t$$

$$FCR = \frac{C}{W_f - W_i}$$

Where: C-food consumed, Wt-1-weight of prawn in hapa net at time t-1.

Data on mean final weight and number of prawns was used to compute production for each treatment using the following formulae;

$$P = \frac{W_m \times N_f}{A}$$

Where: Nf-number of prawns harvested, Wm- mean final weight, A-hapa net area.

Computed growth parameters: Condition factor, AGR, BWI, SGR, survival, food conversion (FCR) and production were compared using ANOVA for parametric data and Kruskal-Wallis for non-parametric data. Significant different means were separated using Tukey test at P<0.05.

Results

During the experimentation period, pond water's mean dissolved oxygen content was 6.22±0.05, temperature 29.63±0.03oC, conductivity 41.60±0.04, and salinity of 26.55±0.03 ppt. Juvenile prawns (1.30±0.85cm, 5.26±0.68 cm) were stocked into each 1m3 hapa nets over a duration of 94 days and fed on the respective formulations. The average final length and weight obtained were 7.91±0.18 cm and 3.74±0.22 g, respectively corresponding to an average weight gain of 2.44g.

Table 2

Feed	Initial		Final		Condition factor
	Length (cm)	Weight (g)	Length (cm)	Weight (g)	
Poly-0	4.25±0.68	1.30±0.85	7.93±0.19	3.38±0.23	0.69
Poly-30	5.60±0.68	1.28±0.85	7.01±0.16	2.39±0.20	0.71
Poly-35	3.60±0.68	1.33±0.85	8.28±0.15	4.03±0.19	0.64
Poly-40	5.60±0.68	1.30±0.85	8.40±0.22	3.80±0.27	0.68

The 20 BT juveniles with an average initial weight of 1.28±0.84 g introduced into Hapa nets at the pond in Mtwapa creek over a period of 94 days achieved a final weight of 3.40±0.22g, with a survival of 92.7%. This corresponded to a growth of 1.32±0.08 g, a specific growth rate of 1.00±0.06%.d-1, and a food conversion ratio of 0.60±0.04. The average yield of these hapa net reared prawns was 315.18 kg.ha-1. Nevertheless, there were significant differences in both growth and yield indicators among the diets and exposure periods.

The average weight gain of 2.25±0.07 g.d-1 corresponds to a specific growth of 8.84±0.16%.d-1. There were significant differences in growth rate among diets (WG, F=10.23, P<0.05; SGR, F=11.99, P<0.000), and exposure periods (WG, F=34.17; SGR, F=122.49). The highest weight gain (2.71 g) and specific growth rates (5.74 %.d-1) were recorded on Poly-40 and Poly-35 diets, which were significantly higher than either shrimp meal and poly-30 diets. Poly-30 diet had lower specific growth rate (3.50%.d-1), but weight gain was comparable to the shrimp meal control diet (Table 3).

Table 3

Parameter	Control diet	Poly-9	Poly-16	Poly-26
Initial weight (g)	1.21±0.84	1.28±0.84	1.33±0.84	1.30+0.84
Final weight (g)	3.38±0.23	2.39±0.20	4.03±0.19	3.81+0.27
Growth rate (g)	1.11±0.16c	0.75±0.16d	1.61±0.16a	1.80+0.16a
Absolute Growth rate (g.d-1)	0.02±0.003c	0.014±0.003c	0.028±0.003b	0.034+0.003a
Specific Growth Rate (%.d-1)	0.90±0.12c	0.66 ±0.12d	1.13±0.11b	1.33±0.12a
Food Conversion Ratio	0.56±0.08bc	0.47±0.08c	0.66±0.07ab	0.73±0.08a
Survival rate (%)	85.9±3.0	96.7±3.0	96.7±3.0	91.7±3.2
Yield (kg.ha-1)	290.34	231.11	389.7	349.38

Table 4

Feed type	N	BWI (g)	SGR (g.d-1)
Shrimp meal	261	1.95±0.16b	4.31±0.32b
Poly-30	294	1.69±0.16b	3.50±0.32c
Poly-35	323	2.63±0.15a	5.73±0.33a
Poly-40	259	2.71±0.16a	5.74±0.32a

The lowest weight gain (1.79±0.09 g) and specific growth rate (1.74±0.19%.d-1) occurred after 4 weeks, thereafter weight gain and specific growth rates were comparable and significantly higher. There was a significant interaction between feed type and exposure (WG, F=1.92, P<0.05; SGR, F=2.51, P<0.05). After 4 weeks of exposure weight gain and specific growth rates among the diets were similar. Thereafter weight gain and specific growth rate in Poly-35 and Poly-40 diets were always higher than either Poly-30 or Poly -0 (control shrimp meal diet) (Figure 1). Between shrimp meal control, (poly- 0) and Poly-30 diets, weight gain and specific growth rates were comparable upto 6 weeks of exposure, but thereafter the control diet continued increasing to significantly higher levels, than poly-30 diet, which remained steady (Figure 2).

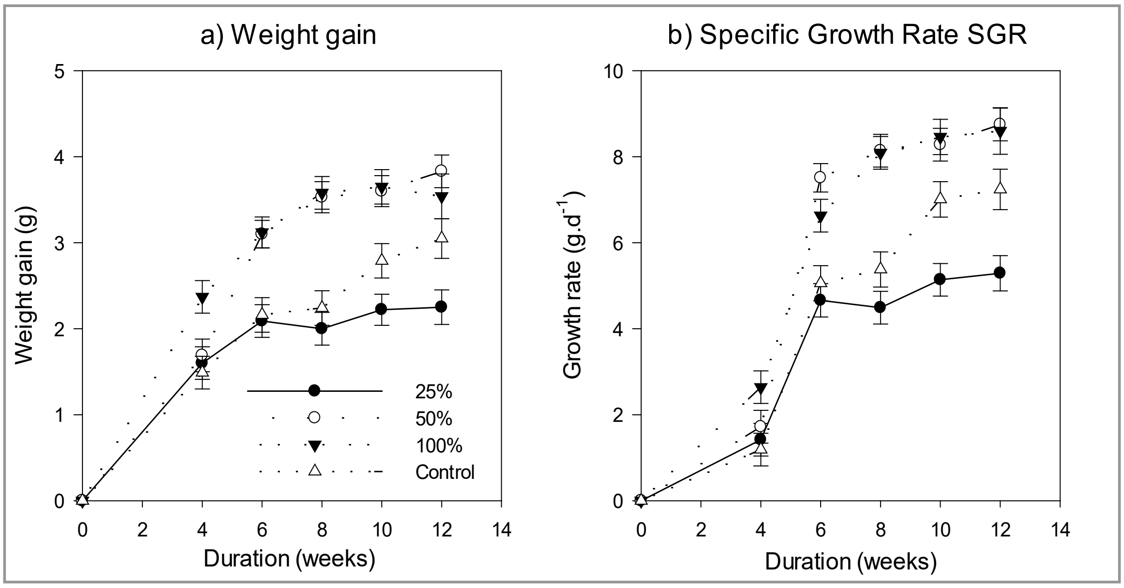

Figure 3

Mean shrimp food conversion ratio was 1.86±0.06, with survival of 92.7±1.5 0% corresponding to a productivity of 24.13±0.65 g.m-2. While there was no significant difference in FCR P(x=4.32) and survival (x=1.23), production was significantly different among the diets (F=19.99, P<0.05). The highest productivity (30.19.37 g.m-2), was realized using Poly-35 diets and was comparable to Poly-40 diets, but significantly higher than either poly-30 or control diet, Poly-0 (Table 5). Control diet (Poly-0) and poly-30 diet had the lowest production of less than 19 g.m-2 (Table 5).

Table 4

Feed Type	Food Conversion efficiency (g.g-1)	Survival (%)	Production (g.m-2)
Shrimp meal	1.84±0.12	85.9±3.0	19.02±1.26b
Poly-30	1.86±0.12	96.7±3.0	19.45±1.28b
Poly-35	1.88±0.12	96.7±3.0	30.19±1.28a
Poly-40	1.86±0.12	91.7±3.2	27.85±1.34a

SGR was positively and significantly correlated to protein content (r2=0.35), with a slope of 0.14 and intercept of 1.14.

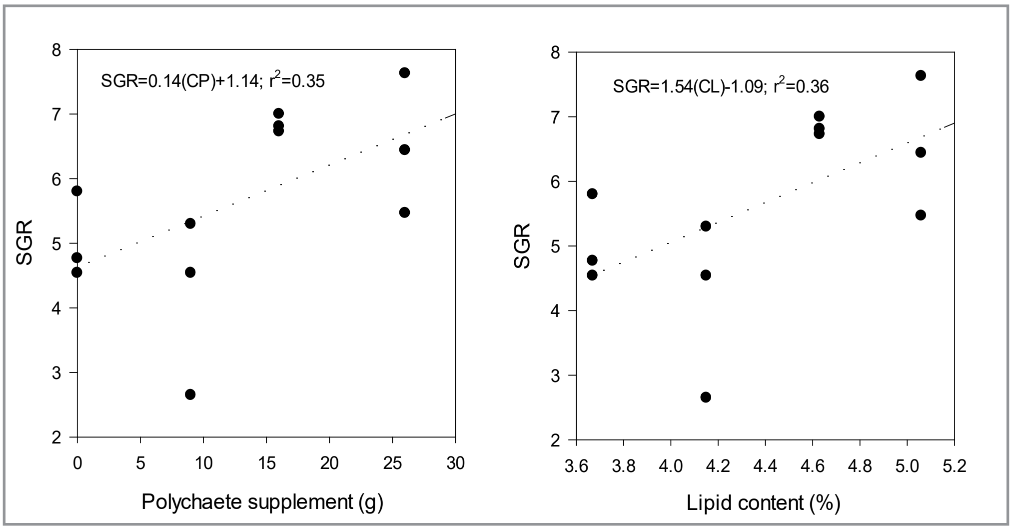

Figure 4 **Figure 5**

Discussions

Apart from salinity (27 ppt), other pond physicochemical conditions; temperature 30oC (25-35oC, and Dissolved oxygen (DO) 6.22 (6.3-6.8 mg.l-1), are within optimal ranges for tiger shrimp growth reported elsewhere [15, 16]. Ideal salinity of between 32-33 ppt are reported (Yu et al, 2009), but broader salinity tolerance of tiger shrimp (10-35 ppt), have also been cited [17, 18]. Prawn morphometrics reported here; mean length of 7.91 cm, and weight of 3.74 g, are comparable to those obtained by Anand et al., (2015), on biofloc diet in earthen pond (length, 6.9 cm; weight, 3.4g; condition factor, 0.8 to 0.84) [19]. The values are however lower (L-11-20 cm; W 2-59g; k 0.6-0.8), than those reported during the Southeastern Monsoon period from wild penaeid prawn at the Ungwana bay, Kenya [3]. This is probably due to the shorter culture period (94 d), compared with wild stock that survives up to 3 years and seasonal spawning. Although differences in condition factor were not significant, the lowest condition factor (0.70) was associated with the low protein content control meal compared to polychaete infused diets. The higher condition factor indicates plumpness of harvested individuals and consequently fat content and taste.

Reported average tiger shrimp growth parameters in hapa nets are; weight gain; 1.35 g.d-1, SGR 1.35%.d-1, and performance indicators FCR, 0.60, survival, <90% and production 24.14 g.m-2, are obtained at stocking densities of 10.m-2 and diet of between 25 and 40cp. Although generalizations are difficult to obtain due to variation in the culture system, diet, and stocking density among others, these performance indicators are generally higher than those obtained from most outdoor pond mariculture, comparable to indoor aquaria but lower than from most open water floating cage cultures elsewhere. Higher performance than open pond is attributed to more efficient feeding, but lower performance than on floating cages is due to greater tidal clearance of biofouling. Furthermore, most of the other BT shrimp cultures adopt higher protein feeds (<35% cp) and consequently higher performance indicators and yields.

Table 6

Culture conditions	SGR	FCR	Production	Ref
Earthen wi 2.7g, pm, manure			24-64 kg.ha.yr	Wyban et al 1987 [20]
25-50.m-2, closed			25-58	Thakur & Lin, 2003 [21]
Pond, no feed			0.14 t.ha-1	Mirera & Samoilys, 2008
Hapa, pm, 1.m-2, poly	1.01	0.60	0.24 t.ha.yr-1	This study
Pond, fed			0.426 t.ha	Le Boutex, 1985
Cp 38, biofloc, 130 d, 8.m-2, Pm		1.15	1640	Anand et al, 2015
Pond, 20.m-2, pm		1.25	2.56	Shailender et al, 2012
Pond, pm, Wi 2.3g	2.3-2.6	1.6-2.0		Mahmood et al, 2005 [22]
aquaria		1.7-2.0		
25-35 cp, biofloc, indoor, pm	3.53	0.97	-	Supriatna et al, 2019 [23]
Hs, sea pen, juvenile				
Cage, 35%cp, Ma	0.2-1.2	1.4-1.9	0.8-1.9t.ha	Ponce-Palafox et al, 2018
Aquaria, 50%cp, pm	0.45-4.44			Tsutsui et al, 2010 [24]
Probiotic, aquaria, 270 ind.m-3, 70d	4.3-4.7	1.5-1.7		Widarnani et al 2019 [25]
Cage, <28% cp, hapa, On	1.5-2.1	1.4-2.5	>0.15t.m-3	Ofori et al, 2009 [26]
Fw, On, cage, <1 kg.m-3		1.7-2.2	>0.2 t.m-3	Blow & Leonard, 2007 [27]
<38%cp, 84d, pm	3.3-3.4	1.4-1.9	4928	Chakrabarty et al, 1996
Poly, Pm+On, 10/m2		1.8-2.9	18-61 g.m-2	Simao et al, 2013
Cage, 40%cp, biofloc/peri, Lv		2.9	2.7-6.5 kg.m-2	Effendi et al, 2016
Biofloc, 23%cp, Ps	3.8-4.0	2.8-3.0		Hussain et al, 2011 [28]
Cage, 0.5g, Pv		2.6-3.2	400-800g.m-2	Paquette et al, 1998
Cage, 125m3, 34%cp, On			10-14kg.m-3	Orina et al, 2018
Fw, cage, Ts			>0.15t.m-3	Rojas & Wadsworth, 2007
Cage, 1179.m3,Pm		4.0	1.62 kg.m-3	Maheswarudu et al, 2016
Recycle, 10,15,20/m2, Mt	1.7-1.9	4.3-5.2		Pena-Herrejon e al, 2019
Hapa, pm, 1-2.m-2, trash fish		5.2	8-14 t.ha.yr-1	Allan & Fielder, 2003 [29]

Greater growth performance with poly-40 and 35 diets; weight gain (<1.6 g.d-1), SGR (<1.1 %.d) and yield (<30 g.m-2), than either poly-30 or control diet is reported. Lower performance under the later diets is attributed to insufficient protein (>30%) and lipid (>4.5%) content in the meals. Ideal protein 35-55% cp, and lipid 5-10% have been successfully adopted elsewhere

[30]. Consequently, shrimp growth rates increased almost linearly during the first 6 weeks of exposure but thereafter slowed down, especially with less than 25% polychaete supplemented. For treatment with over 30% poly replacement slow down occurred after 8 weeks. Weight gain among all diets increased upto the sixth week, especially for poly-25% diets, for the 50% and 100% poly diets peak weight gain occurred at the 8th week. Poly 50% (30% protein) and 100% (40% protein) had similar patterns but were significantly higher than control diets and 25% poly diet, especially after 6 weeks of exposure [31, 32].

The shrimp growth rate was positive and significantly correlated to dietary protein content.

Conclusions and Recommendations

This study aimed to compare the growth performance of Juvenile tiger prawn) when fed on the four formulated feeds rations containing polychaete and shrimp meal ingredients in the ratio poly 0%. Poly 25%, poly 50% and Poly 100%.

At the end of the experiment, BT juveniles fed on higher polychaete diet experienced the highest weight gain (2.71 g) and specific growth rates (5.74 %.d-1) Poly-40 and Poly-35 diets, which were significantly higher than either shrimp meal and poly-30 diets. Thus, higher percentage polychaete diets exhibited ability to achieve higher growth rates as compared to lower percentage of polychaete diets and shrimp meal (Control diet). Overall, the shrimp growth rate was positive and significantly correlated to dietary protein content. Increasing crude protein above 35 increases growth rate of BT prawns.

On survival rate of the BT juveniles, the results portrayed no significant differences among the diets. However higher growth rate exemplified in diets with higher protein and lipids (35 cp) and lipids of above 4.0 implies that Polychaete based diets with higher protein and lipids can be a good substitute to shrimp-based diets in the culture of BT prawn juveniles.

The study also experimented on the Food conversion ratio of the various diets. On F.C.R and based on the results generated that implied Poly-40% and Poly-35% had similar patterns but were significantly higher than control diets and 30% poly diet, We, therefore, conclude that Higher poly diets have a higher F.C.R as compared to lower Poly diets and the fresh shrimp-based control diet experimented.

From the study results and conclusion, the following are the recommendations for further exploring:

1. he study was carried out by feeding the BT prawns on 3% body weight due to limited cultured polychaetes availed for the study. Further study should be done in investigating the best culture protocols for polychaetas to ensure adequate supplies for different feeding regimes. A recommendation is therefore encouraged for further study to examine performances on different feeding percentages.
2. Due to the limitation associated with collection of wild sourced BT juveniles in term of uniform age and size at the time of experiment, it is highly recommended for hatchery sourced juveniles for further study on growth and survival.
3. By being provided in masses, polychaetes worms recorded a superior protein diet and lipids, for the growth and survival of black tiger prawn hence a suitable substitute to Shrimp meal in BT prawns feed formulation.

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