

Development of effective nursery feed for tiger shrimp *Penaeus monodon*



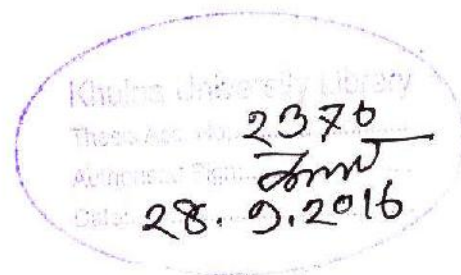
A Thesis

By

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Examination Roll No: MS-110610

Session: 2010-2011

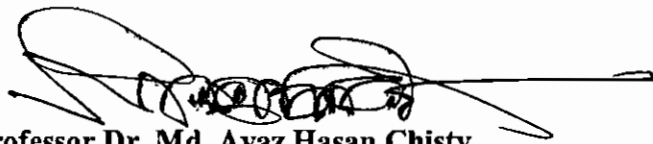


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for the degree of Master of Science in Fish Genetics and Biotechnology

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Development of effective nursery feed for tiger shrimp *Penaeus monodon*

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Declaration

Development of effective nursery feed for tiger shrimp *Penaeus monodon*

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.



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DEDICATED

TO

MY BELOVED PARENTS

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Abstract

The present study was conducted to develop artificial diets for shrimp post-larvae using locally available ingredients, to develop nursery management technique in Hapa system in pond condition and to determine the FCR & SGR for shrimp nursing in pond condition. The growth trial was conducted at the Shrimp Research Station, Bagerhat in aquarium water (<10 ppt) with high water exchange rate (50 % water exchange every three days interval). Post larvae of *Penaeus monodon* was collected from Cox's Bazar and were reared at a rate of 5 PLs/ L aquarium fed on the Feed-1, Feed-2, Feed-3 and made with different composition and Feed-4 (commercial feed - Mega pre nursery). In order to determine growth and survival rates of *P. monodon* post-larvae in pond condition, rearing experiments were carried out in glass nylon net hapa using hatchery-produced post-larvae (PL-10). Twelve hapa (each 4 m³) was installed in ponds and post-larvae (PL-10) were stocked at the rate of 500 PL/m² and reared for a period of 45 days. The primary fertilization was applied with cow dung (100 ppm), coconut oil cake (20 ppm), urea (2 ppm) and superphosphate (2 ppm) for primary production in ponds also. Post larvae of *Penaeus monodon* obtained from Cox's Bazar and reared at a rate of 700/ m³ fed on the Diet-1, Diet-2, Diet-3 and commercial diet. The trial conducted with four treatments each with three replications. The study revealed that in aquarium highest value was found to be 0.09±0.0006 g final weight, 6.40 % specific growth rate and 55.7 %; moreover lowest FCR, 1.52 was also found among all the four types of feeds. In case of pond nursing system, F-3 also showed better performance rather than others with the value of 0.4328±0.045 g final weight, 6.45 % specific growth rate, lowest FCR 1.35, and 73. 4 % survival. In contrast, F-1 showed the lower performance than that of other feeds. It is an observation that formulated feeds with available ingredients revealed better results and it could be a good step for shrimp nursing if it is possible to implement the technique for experimental or even mass culture.

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CHAPTER ONE

Introduction

Chapter 1: Introduction

Tiger shrimp farming is currently the main income generating activity of the people of South-western Bangladesh. About 95% of farms in the study area were largely depended on wild fry collection for stocking Post-Larvae (PL) until 1996. Having serious implications for biodiversity, at present the same percent of farms are depended on the hatchery bred PL, supplied from the south-east region particularly from Cox's Bazar. Quality shrimp nursery feed is an essential prerequisite for the successful nursing as well as farming. Like other crustaceans, *Penaeus monodon* requires highly nutritious food for growth and survival in the early stages of its life cycle. Artificial feed is a reliable alternative and may be used as a substitute or supplement to live feed. However, there is a shortage of quality supplemental shrimp feed in Bangladesh (Hussain, 1994; Hossain, 1995; Karim, 1995; Khan, 1995). But now-a-days, huge amount of different nursery feeds are used for shrimp nursing in this region. The available shrimp feed types are pre-nursery, nursery, starter-1, starter-2, starter-3 and grower. Shrimp feeds, usually with a shelf-life of about three months, are also imported from Thailand and Taiwan. It has been reported that stale feeds are supplied at the farm level, leading to adverse effects on shrimp farming (Karim and Aftabuzzaman, 1995). Consequently, most farmers rely on natural feed and their farms suffer from lower productivity. Therefore, there is a need to develop low cost but effective diets. Use of locally available low cost feed ingredients as well as nonconventional sources of nutrients is being pursued for the development of shrimp nursery feed. Hence, a study is necessary to know the nutritive value of the locally available feed and feed ingredients used for shrimp rearing, which ultimately will help to develop a low cost quality nursery feed.

Shrimp farming in Bangladesh has emerged as an important export oriented industry during the last two and half decades due to high demand and price of shrimp in national and international markets, suitable environments for its production and the government incentives. Shrimp farming is one of the most important economic activities in the coastal region of Bangladesh contributing significantly to national export earnings, employment generation and poverty alleviation. About 80% of exported shrimp is produced in greater Khulna (Khulna, Satkhira and Bagerhat) region of Bangladesh. Quality feed plays a vital role in the sustainable development of shrimp aquaculture (Edward, 1997). For mitigating the current demand hundreds of shrimp and fish feed industries have been established in Bangladesh but maximum feeds are not good in quality as the companies declared. Major costs of shrimp farming are feed and shrimp seeds. Good production and profit entirely rely on feed and its palatability. While commercial feeds are stored at farm level their nutrient components also degrades because of oxidation, enzymatic reaction and biological spoilage with the passage of time (Ping *et al.*, 2000). As a result, the farmers have to face a lot of problems for selecting quality feeds from the markets. These not only make them financially looser but also hamper the national fish and shrimp production (Begum, 2008). Quality nursery feed for shrimp is an essential pre-requisite for the successful rearing as well as farming. Like other crustaceans, black tiger shrimp (*Penaeus monodon*) requires highly nutritious food for good growth and survival in the juvenile stages of its life cycle. But there is a great shortage of quality supplemental shrimp feed in Bangladesh (Hussain, 1994; Hossain, 1995; Karim, 1995; Khan, 1995). Huge amount of different nursery feeds have been used for shrimp farming but nutritive values of the most feeds are poor and costly. Thereby, nursery feed occasionally causes lower growth, survival as well as lower production of shrimp. Locally available feed ingredients and nonconventional sources of nutrients may be used for the

development of low cost quality nursery feed to solve the feed problem. Considering the above circumstances, the experiment was taken to prepare low cost good quality nursery feed using local ingredients for sustainable shrimp production in coastal areas of Bangladesh.

Objectives of the study

- To develop artificial diets for shrimp post-larvae using locally available ingredients
- To develop nursery management technique in Hapa system in pond condition
- To determine the FCR & SGR for shrimp nursing in pond condition

CHAPTER TWO

REVIEW OF LITERATURE

Chapter 2: Review of literature

In common with poultry or salmon, shrimp have a dietary requirement for 40 or so essential nutrients (Cuzon *et al.*, 2004). However, in marked contrast to existing commercial poultry & salmon farming operations where animals are raised almost exclusively within intensive farming systems and fed nutritionally complete artificially compounded diet for their entire life cycle (Beveridge, 2004; Leeson and Summers, 1997), shrimp are currently farmed under a wide range different production systems and fed an equally diverse array of different foods and feeding strategies throughout their life cycle (Cuzon *et al.*, 2004; Jory *et al.*, 2001; Tacon, 2002).

Shrimp feed is a key component of modern shrimp technologies and there is a shortage of artificial shrimp feed in Bangladesh (Hossain, 1995; Hussain 1994; Karim, 1995; Khan, 1995). The growth and production of farmed shrimp is largely dependent upon the supply and intake of dietary nutrient inputs and feeds (ADB/NACA, 1998; Akiyama and Chawang, 1989). Shrimp feeding in Bangladesh first started with farm-made aqua feed and commercial aqua feed also available now. No statistical information currently exists on total global production of farm made aqua feeds for shrimp feeding (New, 1998). The use of farm made aqua feed is usually restricted to resource poor farmers in Asia (ADB/NACA, 1998), and farm-made aqua feeds will in all livelihood be gradually replaced by commercial aqua feeds (Tacon, 2002).

There are 83 conventional and non conventional ingredient items irrespective of nutritive value, price and availability can be economically used for the manufacture of quality fish feed (Bhuiyan *et al.*, 1989). They reported that less than 10% protein content in 24 ingredients, 10-30% protein in 42 ingredients; 30-50% protein is 8 ingredients and more than 50% protein in 9 ingredients. Four ingredients can be said to be of serious competing use, these are soybean oil meal, rice

bran, fishmeal and wheat by-products (Cruz, 1997). Hossain (1996) determined proximate composition of 15 locally available protein source fish feed ingredients from animal and plant origin. He obtained 45.2 %, 33.3 %, 36.5 %, 38.96 %, 35.7 % protein content for soybean meal, sesame meal, mustard oilcake, linseed meal and cottonseed meal, respectively from plant sources and 56.4 %, 56.8 %, 61 %.1 and 75.5 % for fishmeal, fish silage, silkworm pupae and poultry offal respectively from animal sources as high protein ingredients (>30 %) and rice bran (12.6 %) and wheat bran (18.2 %) as low protein ingredients. Considering the increasing of fish meal and doubt concerning its long term availability, much research carried out on the use of plant and animal bi-products as fish meal substitutes (Hasan *et al.*, 1997; Tacon *et al.*, 1984; Stickney *et al.*, 1996). Protein requirement for *P. monodon* is ranging from 34-46 % of dry diet (Hasan, 2001).

Under natural condition, *Macrobrachium rosenbergii* is an omnivore, feeding on various plant and animal materials (Balazs and Ross, 1976). The scampi are fed with farm-made or commercial feeds in order to boost up the production volume. While prawns can receive substantial nutritional benefit from natural foods at relatively low biomass densities (< 1,000 kg/ha) (Tidwell *et al.*, 1997), at higher stocking densities individuals may be more dependent on prepared diets (Tidwell *et al.*, 1999). An appropriate feeding is a major factor behind the success in aquaculture. Shang and Fujimura (1977) and FAO (1986) estimated feed cost to account for about 13 - 27% of the total annual cost of production in *Macrobrachium rosenbergii*. Protein, being an important dietary constituent among animals, directly influences the formulation of diet and consequently affects the cost of production. The quality and quantity of dietary protein strongly influence growth rate in fishes (Love, 1980; Wilson and Halver, 1986). Data on the nutritional requirements of *Macrobrachium rosenbergii* are scarce. Several workers have tried to

develop artificial diets capable of sustaining good growth using a variety of foodstuffs (Kanazawa *et al.*, 1970; Cowey and Forster, 1971; Deshimaru and Shegino, 1972; Sick *et al.*, 1972; Andrews *et al.*, 1972; Balazs *et al.*, 1973, Venkataramiah *et al.*, 1975; Balazs and Ross 1976; AQUACOP 1976; Zein-eldin and Corliss 1976; Sedgwick 1979; Boonyaratpalin and New 1980; Bartlett and Enkerlin 1983; Das *et al.*, 1996; Venkataramani *et al.*, 2002; Anh *et al.*, 2009). Experimentally, the use of ingredients of vegetable materials was also tried with the aim to lower the production costs as most of the protein sources used (squid meal, clam or mussel, shrimp meal, etc.) are far beyond the reach of the average fish farmer in terms of costing (Watanabe *et al.*, 1993; Kaushik *et al.*, 1995; Nyirenda *et al.*, 2000; Boonyaratpalin *et al.*, 1998; Krishnankutty and Sujatha 2003; Krishnankutty 2005).

Hossain *et al.* (2004) conducted an experiment for development of a suitable diet using locally available feed ingredients for monoculture of giant fresh water prawns *Macrobrachium rosenbergii* in ponds. Three formulated diets were prepared from fishmeal, meat and bone meal, mustard oilcake, sesame meal and rice bran. For control a special shrimp feed (Starter-III) from Saudi Bangla Fish Feed Ltd. was used. The result showed that a diet containing 20 % fish meal, 10 % meat and bone meal, 15 % mustard oil cake, 15 % sesame meal, 35 % rice bran, 4 % molasses and 1 % mineral vitamin could be recommended for monoculture of *M. rosenbergii* in ponds which is cheaper than commercial prawn diets available in market.

Hossain and Islam (2007) conducted an experiment to evaluate the meat and bone meal (MBM) as partial replacement for fish meal in *Macrobrachium rosenbergii* post larvae. These nursery diets were formulated containing 32 % FM and protein and FM in these diet was progressively replaced with MBM (Diet 1 contained 25 % FM and 14 % MBM, Diet 2 contained 20 % FM and

20 % MBM and Diet 3 contained 15 % FM and 26 % MBM). Inclusion level of mustard oilcake (MOC) and sesame meal (SM) in diets were kept fixed at 10%. A commercial shrimp nursery diet (30 % protein) from the Saudi Bangla Fish Feed Ltd. was used as reference diet (Diet 4).

The result of the study demonstrated that the MBM could be included at 14% level in nursery diet and a diet containing 25 % FM, 14 % MBM, 10 % SM and 10 % MOC be recommended for profitable production of *M. rosenbergii*. Department of Fisheries in Thailand approved nutrients standards for shrimp feed formulation containing 35-38 % protein and 4-5 % fat for marine shrimp (Tacon, 2002). Fresh water snail is fully decline in Bagerhat district due to excessive harvesting, which are traditionally used as prawn feed (Ahmed and Hossain, 1999). Bobeotuburan *et al.* (1995) got significant results when they used snail meat as feed for the tiger shrimp.

Khan *et al.* (2004) conducted an experiment to evaluate growth and survival of *Penaeus monodon* post larvae under three different stocking densities of 100, 150 and 200 PL/ m², were tested in brackish water ponds for a period during the months of April-May, 2002. The PLs were fed with a commercial shrimp feed (Saudi-Bangla nursery feed) at a rate of 25% body weights during the whole experiment period. The growth and survival rates were higher in ponds having lower stocking densities.

Ali and Mazid (2005) conducted an experiment to improve nursery management technology of golda chingri (*Macrobrachium rosenbergii*). They showed that water exchanging every 3 day's interval at the rate of 30-40% and a stocking density of 5 PLs/ L gave better growth and survival rate.

CHAPTER THREE

Materials and Methods

Chapter 3: Materials and Methods

Experimental design in aquarium condition

The growth trial was conducted at the Shrimp Research Station, Bagerhat in aquarium water (<10 ppt) with high water exchange rate (50 % water exchange every three days interval). Post larvae of *Penaeus monodon* was collected from Cox's Bazar and were reared at a rate of 5 PLs/L aquarium fed on the Feed-1, Feed-2, Feed-3 and Feed-4 (commercial feed). The trial was conducted with four treatments each with three replications. Treatment T1 was assigned for experimental Feed-1, T2 for experimental Feed-2, T3 for experimental Feed-3 and C for Feed-4 (Control). Daily feeding rate was 35-50 % of total biomass to ensure feeding to satiation and dividing into 3 rations at 8 hours interval.

Gentle aeration was provided to each aquarium for the 30 days of the experiment. Sampling was done at PL10, PL15, PL20, PL25, PL30 and PL35 for measurement of growth and survival. Faecal matter of shrimp was removed by siphoning once a day in the morning before feeding. Water quality parameters; temperature, P^H, D.O, and ammonia were also monitored at the same time.

Experimental design in pond condition

In order to determine growth and survival rates of *P. monodon* post-larvae in pond condition, rearing experiments were carried out in glass nylon net hapa using hatchery-produced post-larvae (PL-10). Twelve hapa (each 4 m³) will be installed in ponds and post-larvae (PL-10) were stocked at the rate of 500 PL/m² and reared for a period of 45 days. The primary fertilization was applied with cow dung (100 ppm), coconut oil cake (20 ppm), urea (2 ppm) and superphosphate (2 ppm) for primary production in ponds also.

Post larvae of *Penaeus monodon* obtained from Cox's Bazar and reared at a rate of 700/ m³ fed on the Diet-1, Diet-2, Diet-3 and commercial diet. The trial conducted with four treatments each with three replications. Treatment T1 assigned for experimental diet-1, T2 for experimental diet-2, T3 for experimental diet-3 and C for commercial diet (Control).

Table 3.1 Feed formulations for nursery rearing of tiger shrimp *Penaeus monodon*

Ingredients	T1 (F1)	T2 (F2)	T3 (F3)	C (Control)
QL fish meal	45	36.5	32	Mega pre nursery
Dhayncha seed Soaked (<i>Sesbania spp</i>)	20	15	10	
Soyabean Meal	-	25	24	
Mustard Oil Cake	18	-	20	
Rice polish	5	12.5	5	
Wheat bran	5	12.5	6	
Wheat flour	4	4	4	
Vit. & Minerals premix	1	1	1	



Table 3.2 Feed formulations for nursery rearing of tiger shrimp *Penaeus monodon*

Ingredients	T1 (F1)	T2 (F2)	T3 (F3)	C (Control)
QL fish meal	45	45	32	Mega pre nursery
Dhayncha seed Soaked (<i>Sesbania spp</i>)	40	25	-	
Soyabean Meal	-	-	32	
Mustard Oil Cake	-	-	20	
Rice polish	5	12.5	5	
Wheat bran	5	12.5	6	
Wheat flour	4	4	4	
Vit. & Minerals premix	1	1	1	

Table 3.3 Feeding practice during the rearing period of post-larvae of *Penaeus monodon*

Duration	Daily ration (gm)	Method
1 st week	5	Tray
2 nd week	10	
3 rd week	15	

4 th week	20	
5 th week	25	
6 th week	30	

The present investigation was conducted to study the efficacy of four different feeds viz., Feed-1; Comprising of fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1% , Feed -2; fish meal 45%, soya-bean meal 25%, rice polish 12.5%, wheat bran 12.5%, wheat flour 4% and vitamin & minerals 1%, Feed -3; fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1% and Feed-4; Mega Nursery Feed (Commercial). All the four feeds were iso-proteineous containing 40% of protein.

Experiment-1: Efficacy of formulated feed for shrimp nursing in laboratory condition

The growth trial was conducted at the Shrimp Research Station, Bagerhat in aquarium water (≤ 10 ppt). The trial was conducted with four treatments each with three replications. Treatment-1 was assigned for Feed-1 (T_1), treatment-2 (T_2) for Feed-2, treatment-3 (T_3) for Feed-3 and control (C) for Feed-4 (Commercial feed). The glass aquarium was provided with aeration and 50 % water was exchanged daily. Feed was supplied at the rate of 10 % of the total biomass twice a day. Faecal matter of PL was removed by siphoning once a day in the morning before feeding.

Stocking and sampling for growth and survival

Post larvae of shrimp (*P. monodon*) with average body weight of 0.005g were collected from Cox's Bazar and stocked at rate of 5 PLs/L aquarium fed on the Feed-1, Feed-2, Feed-3 and Feed-4 (Commercial feed). Sampling was done at PL₂₀, PL₃₀ and PL₄₀ for the measurement of growth and survival.

Experiment-2: Efficacy of formulated feed for Bagda nursing in pond condition

In order to determine growth and survival rates of *P. monodon* post larvae in pond condition rearing experiment was carried out in glass nylon net hapa using hatchery-produced post larvae (PL₁₀). Twelve hapa (Each 4 m³) was installed in pond. The fertilization was applied with cow dung (100 ppm), urea (2 ppm) and superphosphate (2 ppm) for primary production in pond also. Post-larvae were fed on the formulated Feed-1, Feed-2, Feed-3 and Feed-4 (Commercial feed). The trial was conducted with four treatments each with three replications. Treatment-1 (T₁) was assigned for Feed-1, treatment-2 (T₂) for Feed-2, treatment-3 (T₃) for Feed-3 and Control (C) for Feed-4 (Commercial feed). Feed was supplied at the rate of 10 % of the total biomass twice a day.

Stocking and sampling for growth and survival

The shrimp PL of average body weight of 0.005 g stocked at rate of 500 PL/m² and reared for a period of 40 days.

Statistical Analysis

Statistical analysis of the data was performed by ANOVA (Analysis of variance). All Statistical analyses were done by using MS Excell 2000 (version 7.0).

CHAPTER FOUR

Results and Discussion

Chapter 4: Results and Discussion

In case of experiment-1 the following results were found:

Growth rate

After 30 days culture, the highest growth performance of 0.0954 ± 0.0006 g and the lowest of 0.0844 ± 0.0029 g were recorded in post larvae supplied with Feed-3 (consisting of fish meal 32 %, soya-bean meal 32 %, mustard oil cake 20 %, rice polish 5 %, wheat bran 6 %, wheat flour 4 % and vitamin & minerals 1 %) and Feed-1 (fish meal 45 %, dhaincha seed meal 40 %, rice polish 5 %, wheat bran 5 %, wheat flour 4 % and vitamin & minerals 1 %) respectively. The increase in growth rate of PL is shown in Fig. 1. The highest specific growth rate of 6.40 and the lowest food conversion ratio of 1.52 were also observed in T₃. Different growth parameters of PL with different feeds are shown in Table 4.1. These findings are supported by Ali and Mazid, 2005; Hasan *et al.*, 1997; Khan *et al.*, 2004; Tacon *et al.*, 1984 and Tidwell *et al.*, 1999.

Table 4.1 Growth performance of PL using different feeds in Aquarium System

Treatments	Initial wt. (g)	Final wt. (g)	SGR* (% days)	FCR	Survival Rate (%)
T ₁ (feed-1)	0.005	0.0844 ± 0.0029	6.13	1.68	48.3
T ₂ (feed-2)	0.005	0.088 ± 0.0008	6.24	1.61	50.2
T ₃ (feed-3)	0.005	0.09 ± 0.0006	6.40	1.52	55.7
C (commercial feed)	0.005	0.0899 ± 0.0015	6.27	1.55	52.5

*SGR=Specific Growth Rate

Survival rate

The initial stocking density of the post larvae was 175 in each treatment and the average post larvae were 84.5, 87.8, 97.4, and 91.8 during harvest. At the end of rearing the survival rate of PL were found 48.3 %, 50.2 %, 55.7 % and 52.5 % in treatment T₁, T₂, T₃ and C respectively. So, the survival rate was comparatively higher in T₃ than T₁, T₂, and C. Similar results were found by Ali and Mazid, 2005; Hasan *et al.*, 1997; Khan *et al.*, 2004.

Water quality parameters

Water quality parameters of the aquarium containing PL stocks were studied (Table 4.2). Water temperature ranged from 25-27°C. The P^H of all aquarium water was always alkaline and ranged from 7.2-7.8 (Table 4.2). In all treatments dissolved oxygen concentration ranged between 5.5-6.8 mg/L. Water salinity was 8 ppt that showed similar value in all treatments. The average value of ammonia was higher in C (0.045mg/L) than the values recorded in T_1 , T_2 and T_3 and no significant difference was observed among the treatments. The lowest value was obtained in T_3 . These results are also in agreement with the results reported by Ali and Mazid, 2005; Hasan *et al.*, 1997; Khan *et al.*, 2004.

Table 4.2 Water quality parameters as recorded from aquarium in laboratory condition under different treatments.

Parameters	Treatments				
	T_1	T_2	T_3	T_4	Source water
Temperature ($^{\circ}C$)	25-27 $^{\circ}C$	25-27 $^{\circ}C$	25-27 $^{\circ}C$	25-27 $^{\circ}C$	29.5 $^{\circ}C$
P^H	7.5	7.7	7.4	7.9	7.2
Salinity (ppt)	8	8	8	8	8
DO (mg/l)	6.3	6.5	6.8	6.2	5.5
NH_4 (mg/l)	0.030	0.034	0.026	0.045	0.006

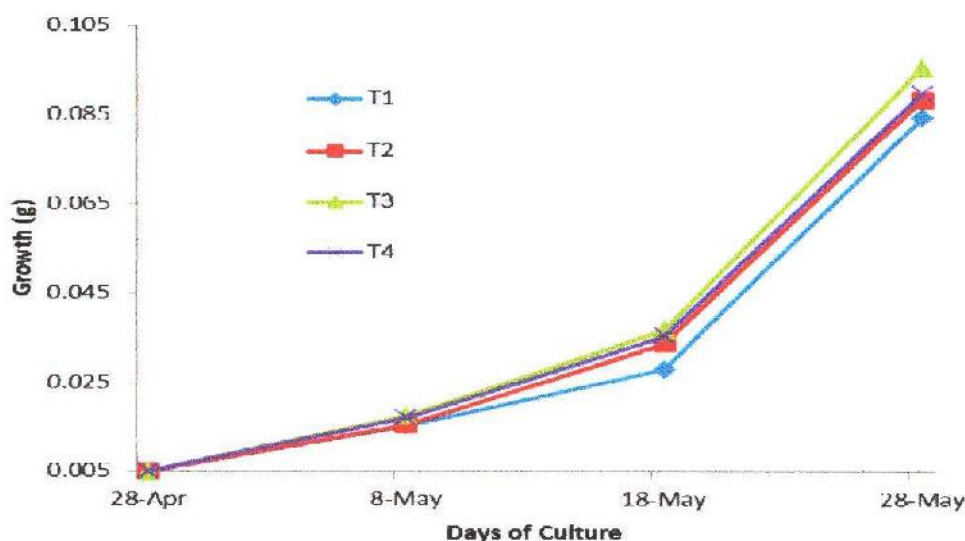


Figure 4.1 Growth rate of PL using different feeds

In case of experiment-2 the following results were found:

Growth rate

After 40 days culture, the growth performance of 0.3120 ± 0.010 g, 0.3567 ± 0.017 g, 0.4328 ± 0.045 g and 0.3934 ± 0.015 g for Feed-1 (T_1), Feed-2 (T_2), Feed-3 (T_3), and Feed-4 (C) (Commercial feed) respectively. The highest growth performance of 0.4328 ± 0.045 g obtained from Feed-3 (fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1%) and the lowest of 0.3120 ± 0.010 g was recorded in post larvae supplied with Feed-1 (fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1%) respectively. The highest specific growth rate of 6.45 and the lowest food conversion ratio of 1.35 were also observed in Feed-3 (T_3). Different growth parameters of PL with different feeds are shown in Table 4.3.



Table 4.3 Growth performance of PL using different feeds in Hapa System

Treatments	Initial wt. (g)	Final wt.(g)	SGR* (% days)	FCR	Survival Rate (%)
T ₁ (feed-1)	0.005	0.3120 ±0.010	5.98	1.50	62.8
T ₂ (feed-2)	0.005	0.3567±0.017	6.17	1.41	65.7
T ₃ (feed-3)	0.005	0.4328±0.045	6.45	1.35	73.4
C (commercial feed)	0.005	0.3934±0.015	6.31	1.39	69.6

**SGR=Specific Growth Rate

Survival rate

The initial stocking density of the post larvae was 2000 in each in treatments and the average post larvae were 1256, 1314, 1468 and 1392 during harvest. At the end of rearing the survival rate of PL were found 62.8%, 65.7%, 73.4% and 69.6% in treatment T₁, T₂, T₃ and C respectively. So, the survival rate was comparatively higher in T₃ than T₁, T₂, and C. The increases in growth rate of PL are shown in Fig 4.2. The above results are supported by Ali and Mazid, 2005; Hasan *et al.*, 1997; Khan *et al.*, 2004; Tacon *et al.*, 1984 and Tidwell *et al.*, 1999.

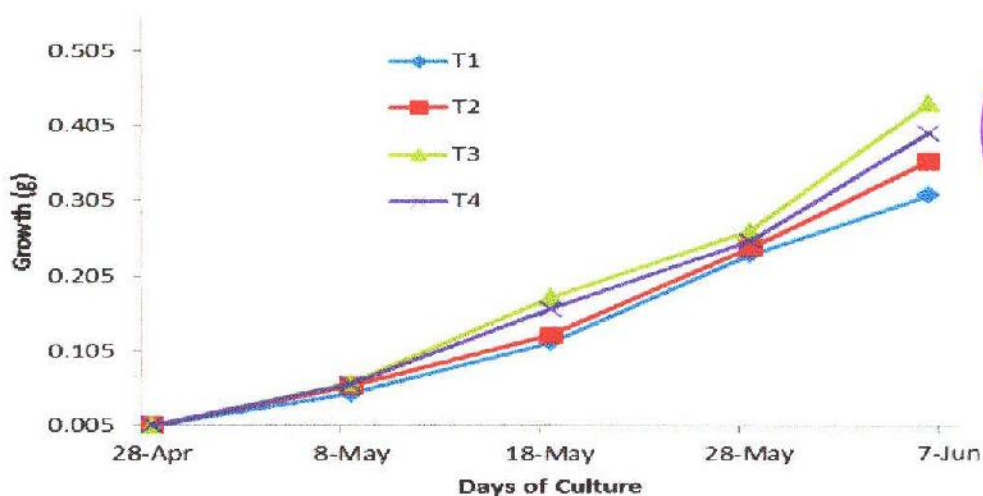


Figure 4.2 Growth rate of PL using different feeds

Water quality parameters

Water quality parameters such as temperature, dissolved oxygen, P^H , salinity and ammonia were recorded by weekly sampling during the study period. The average values of water quality parameters have been presented in Table 4.4. There were no remarkable variations in water temperature, dissolved oxygen, salinity, P^H and ammonia under the four treatments.

Table 4.4 Water quality parameters as recorded from hapa in pond condition under different treatments.

Parameters	Treatments			
	T ₁	T ₂	T ₃	T ₄
Temperature (°C)	28-30 °C	28-30 °C	28-30 °C	28-30 °C
P^H	8.5	8.4	8.5	8.5
Salinity	4.5	4.5	4.5	4.5
DO mg/l	4.6	4.6	4.7	4.6
NH ₄ mg/l	0.032	0.035	0.034	0.035

Water temperature recorded in hapa during the culture period was within the range of 28-30 °C. Water P^H found from hapa was 8.4-8.5 with no remarkable variation among the treatments. No change in salinity levels of hapa water was noticed during the experimental period and was prevailed 4.5 ppt. The values of DO content in T₁, T₂, T₃ and C were found to range from 4.60-4.70 mg/L but there was no significant difference among the four treatments. Same values of DO content (4.60 mg/L) was recorded in T₁, T₂ and C. The values of ammonia (0.032- 0.035 mg/L) were within the suitable range and there were no conspicuous variations among the treatments. The present study confirms differences in survival rate, DGR, FCR and SGR among various formulated feeds, which may be attributed to differences in the component and proportions of feed ingredients. The present study reflects the best growth performance in shrimp fed with

Feed-3. This diet was prepared with fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1%.

The utilization of dietary protein is mainly affected by its amino acid composition, level of protein intake, calorie content of the diet, digestibility of the protein, physiological state of the species, water temperature, and size of the shrimp. The benefit of any aquaculture venture is reflected through the ultimate production figure. However, the highest performance of Feed-3 may be attributed to the specially formulated soybean based feed that not only boosted up the growth of shrimps, but also upgraded the ambient aquatic health (in terms of nutrient load, DO, transparency, organic carbon *etc.*). The highest production in Feed-3 confirmed the positive influence of soybean based protein (48%) on shrimp growth in the present geographical locale.

CHAPTER FIVE

Conclusion

Chapter 5: Conclusion

From the present study the following conclusions can be drawn:

1. As nursery feed for the shrimp (*Penaeus monodon*) the performance of feed-3 (fish meal 32%, soya-bean meal 32%, mustard oil cake 20%, rice polish 5%, wheat bran 6%, wheat flour 4% and vitamin & minerals 1%) has been found to be better in both aquarium condition as well as pond condition than feed-1 (fish meal 45%, dhaincha seed meal 40%, rice polish 5%, wheat bran 5%, wheat flour 4% and vitamin & minerals 1%), feed-2 (fish meal 45%, soya-bean meal 25%, rice polish 12.5%, wheat bran 12.5%, wheat flour 4% and vitamin & minerals 1%) and feed-4 (Control).
2. Because of the lowest FCR (1.35), the highest SGR (6.45) and the highest survival rate (73.4%) the low cost feed-3 can be used in the field level.

CHAPTER SIX

References

Chapter 6: References

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