



EFFECT OF RESTRICTED FEEDING ON GROWTH PERFORMANCE AND FEED UTILIZATION OF FRESHWATER PRAWN (*Macrobrachium rosenbergii*) IN POND AQUACULTURE SYSTEM

Alokesh Kumar Ghosh*, Madhuri Biswas, Md. Abul Kalam Azad, Shikder Saiful Islam, Khandaker Anisul Huq and Md. Saifuddin Shah

Fisberies and Marine Resource Technology Discipline, Khulna University, Khulna 9208, Bangladesh

KUS:18/03: 120318

Manuscript received: March 12, 2018

Accepted: September 19, 2018

Abstract: The present study aimed to evaluate the effect of rate restricted feeding on the growth performance and feed utilization efficiency of prawn (*Macrobrachium rosenbergii*) in improved traditional pond culture system. There was a control group (T₁, *ad libitum* of prawn) and two treatments which were 25% reduction (T₂) and 50% reduction (T₃) of artificial feed than control and each treatment was triplicated. After nine experimental ponds (each was 120 m²) preparation, prawn PL was reared in the nursery pond for 45 days to become juvenile and the juvenile was then stocked in grow out at density of 2/m². After 100 days of culture, the final mean weight was 16.14±8.2, 16.56±1.57 and 19.33±7.75 g for T₁, T₂ and T₃ respectively. Higher SGR (2.89 % BW/d) was found in T₃ which was significantly (*p*<0.05) higher than T₁ (2.67 % BW/d) and T₂ (2.72 %BW/d). Significantly (*p*<0.05) lowest survival rate (71%) was observed for T₃ and highest survival rate (93%) was found for T₁. The feed conversion efficiency (FCR) decreased significantly (*p*<0.05) with increasing feed restriction and lowest value (0.81) was observed for T₃. The protein efficiency ratio (PER) and net apparent protein utilization (NPUa) found to increase with increasing feed restriction which indicates the better utilization of feed. The present study indicates that prawns are subjected to rate restriction of feeding condition was able to maintain the same and even high growth rate as control.

Keywords: Prawn, feed, restriction, growth, FCR, survival

Introduction

Bangladesh is blessed with freshwater prawn (*Macrobrachium rosenbergii*) culture because of vast amount of freshwater and brackish water, suitable resources, geographic position, agro climatic environment, water, soil and available culture technique (Wahab *et al.*, 2012; Ahmed *et al.*, 2008a). Excess feed is considered as one of the major source of wastes that affects water quality, consume 40% operating cost in semi-intensive system and 55%-60% cost in intensive culture system (Boyd and Tucker, 1998; Chanratchakool *et al.*, 1994; Lovell, 1998). Inappropriate feeding practices in pond aquaculture system may lead to over feeding of animal which results in feed wastes resulting high production cost. Conversely, less feeding may cause poor growth and high mortalities which may cause loss in aquaculture business (Eroldoğan *et al.*, 2006). In shrimp and prawn culture system, farm managers usually develop

*Corresponding author: <alokesh_ku@yahoo.com>

DOI: <https://doi.org/10.53808/KUS.2018.15.1and2.1803-L>

feeding table to ensure feed all the day near to satiation level. Restricted feeding table may help to reach desired Feed Conversion Ratio (FCR), but can also lead to negative growth under adverse culture (Nunes, 2004). Under restricted feeding, animals can convert a greater part of feed to body weight without any negative effect on body growth and nutrient utilization than they are supposed to do under unrestricted feeding ration regime (Ali *et al.*, 2003). Additionally, natural food (phytoplankton, zooplankton and bacteria) can provide up to 50-70% of the nutritional requirement of shrimp/prawn (Jory, 2000; Enríquez, 2003; Tacon, 2002). Usually, each food manufacturer recommends feeding rates based only on prawn size and biomass, but they are not considering the availability of natural food and the nutrients produced by fertilization, which lead to overfeeding (Millamena, 1990). In pond culture system, only 17% (dry weight) of the total feed is transformed into shrimp biomass, 20% egested as faeces, 15% is not consumed or leached, 48% covers energy for maintenance, moulting and metabolizing (Primavera, 1993). Nevertheless, there is little or no information available on the effects of moderate or severe feed restriction on the growth performance of prawn in pond culture system. In this study, it has been hypothesized that it is possible to restrict feed exposure and feeding rates without hampering of *M. rosenbergii* growth. So, the present study has been undertaken to determine the effect of restricted feeding on growth performance and feed utilization of prawn in pond culture system.

Materials and Methods

Experimental design: The experiment was conducted with two treatments following a control group. The control group was feeding of prawn at satiation level and was expressed as T₁. The first and second treatments were denoted as T₂ and T₃, which contained group of prawn fed at 25% and 50% reduction of artificial feed than control. Each treatment including the control group were triplicated. The study was conducted for a period of six months (June-November) during the year, 2016.

Pond preparation: Nine rectangular ponds each of 120 m² with an average depth of 1.5 m were used for this experiment. The ponds were dewatered and dried in the sun for one month to remove the unwanted organisms. The embankments of the ponds were repaired and reconstructed. Liming (CaCO₃) was done at a rate of 250kg/hectare on the bottom and dike of ponds. After watering, rotenone was applied at the rate of 6kg/hectare/feet of water depth to eradicate the unnecessary organisms. The ponds were fenced with net to prevent the entering of unwanted organisms. The water depth of the experimental plot was maintained at 1.5 m by adding underground water during the dry season from a central water distribution channel. Moreover, outflow from other ponds was restricted during the experiment period.

Feed and feeding: Commercial feed with 30% protein and 7% fat was used during the experiment period. Before feeding, the feed was analyzed to determine the proximate composition according to the standard procedures given by Association of Official Analytical Chemists (AOAC, 1980). Feed was given by using feeding tray to check the satiation level of prawn (control). Then 25% and 50% reduction of feed than control group was applied in two treatments.

Determination of water quality parameters: Physiochemical parameters of the water quality were measured at seven days interval. Digital Thermometer was used to measure temperature. Water pH was measured using a bench top digital pH meter (DPH-2, ATAGO). Dissolved oxygen (DO) of water sample was measured by Winkler methods. Alkalinity was measured using Neutralization Titration process method following (APHA, 1976) and hardness was measured by complex metric titration (EDTA titration). Ammonia was measured by spectrophoto metric analysis (APHA, 1976).

Data collection: Sampling was done at fifteen days intervals. Fifty individuals of prawn were collected from each pond for weight and length measurement by using cast net. Body weight was recorded by electric balance to the nearest 0.001 g accuracy. At the end of the experiment, all the ponds were dewatered by water pump and all the prawn were harvested completely to determine the survival rate, FCR and other production performance parameters.

$$\text{Survival (\%)} = N_t/N_0 \times 100\%$$

Where N_t is the number of shrimp at the end of the experiment and N_0 the initial number of shrimp;

$$\text{Average weight gain (WG)} = W_t - W_0$$

Where W_t is the final body weight and W_0 the initial body weight of prawn (in grams).

$$\text{Daily weight gain (DWG) (g/day)} = (W_t - W_0)/t$$

Where t is the duration of the growth interval

$$\text{Specific growth rate (SGR) (in \%BW/day)} = ((\ln(W_t) - \ln(W_0))/t) \times 100$$

Where t is the duration of the experiment in days, W_t is the final average individual body weight and W_0 the initial average individual body weight; PER = Increase in the mass of animal produced (wet wt)/Mass of protein in fed; Feed conversion ratio (FCR) = Total amount of feed given (g)/Weight gain (g); Apparent net protein utilization (%) (NPU_a) = Protein gained (g) \times 100/protein intake (g).

Results

Growth of prawn by body weight and length: Initially, the average body weight of prawn was 1g. After 100 days of culture, the harvested weight of prawn was 16.14 ± 8.2 , 16.56 ± 1.57 and 19.33 ± 7.75 g in T_1 , T_2 and T_3 respectively. Significantly highest final average weight and weight gain was found for the treatment T_3 than other experimental groups and lowest final weight was observed for the control (T_1) (Table 1). The individual growth of prawn was increased with increasing restriction of artificial feeding. At the end of the experiment, mean weight gain was 15.14 ± 8.2 , 15.56 ± 1.57 and 18.33 ± 7.75 g for the T_1 , T_2 and T_3 respectively (Table 1). Moreover, comparatively higher weight gain was observed for T_3 throughout the experimental period compared to other treatments (Fig. 1).

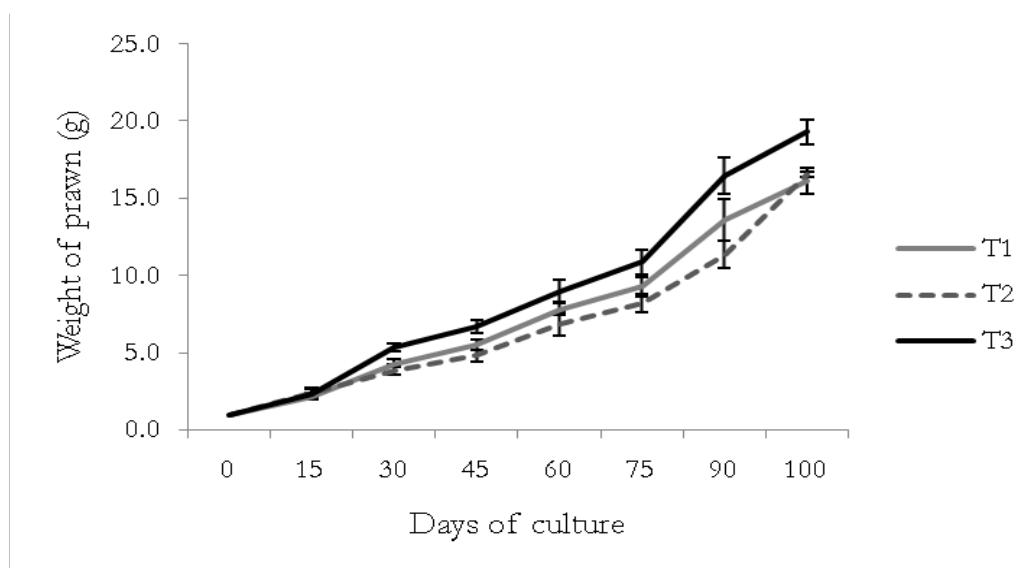


Fig.1:Prawn mean weight at different sampling periods of different feeding treatments

At the end of the experiment the final mean length of prawn in different treatments was 11.7 ± 2.04 , 11.8 ± 1.57 and 12.40 ± 1.51 cm respectively for T₁, T₂ and T₃. Significantly highest mean final length was observed for T₃ (Table 1). Moreover, comparatively higher length was observed for T₃ throughout the experimental period compared to other treatments (Fig. 2).

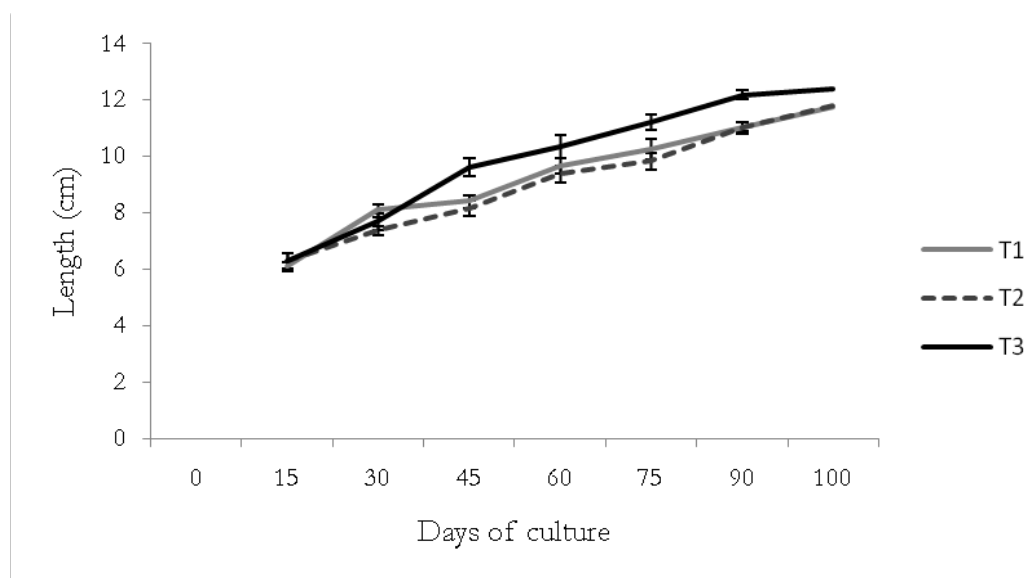


Fig.2: Prawn mean length at different sampling period of different feeding treatments

Survival rate: At the end of the experiment, the survival rate of prawn in T₁, T₂ and T₃ was 93±4.7, 87±12.96 and 71±5.89% respectively. Highest survival rate was found for T₁ in which the prawn was fed at satiation level and lowest survival rate was found in T₃ where the restriction of artificial feed was highest. No significant difference was found between T₁ and T₂ but significant difference was found between T₁ and T₃ as well as between T₂ and T₃ ($p<0.05$) (Table 1).

Specific growth rate (SGR): The mean specific growth rate of prawn in T₁, T₂ and T₃ was found 2.67±0.46, 2.72±0.42 and 2.89±0.40 (BW%/day) respectively (Table 1). Highest SGR was found in T₃ which was statistically significant than other experimental groups. Lowest SGR was found in T₁ in which the prawn was fed at satiation. SGR increased with increasing restriction of feeding.

Daily weight gain (DWG): The mean daily weight gain for T₁, T₂ and T₃ was 0.15±0.08, 0.16±0.02 and 0.18±0.08 g/day respectively. Highest DWG was found in T₃ whereas lowest DWG was found in T₁ ($p<0.05$) (Table 1). The DWG increased with increasing feeding restriction in the experiment.

Feed conversion ratio (FCR): The FCR value was 1.49±0.1, 1.16±0.13 and 0.81±0.08 in the experimental groups of T₁, T₂ and T₃ respectively (Table 1). Highest FCR was found in T₁ (control) which was statistically significant than other groups and lowest FCR was found in T₃ (50% feeding restriction) and intermediate FCR value was found in T₂. FCR decreased with increasing feeding restriction.

Protein efficiency ratio (PER): The PER value in T₁, T₂ and T₃ was 2.23±0.28, 2.86±0.19 and 4.13±0.25 respectively. Highest PER value was found in T₃ which was statistically significant and lowest PER value was found in T₁ (Table 1). The results indicated that when PER was high then FCR was low. The protein efficiency ratio increased with increasing restriction of artificial feeding.

Apparent net protein utilization (NPU_a): The NPU_a in T₁, T₂ and T₃ was 42.80±11.23, 51.32±8.45 and 87.75±13.43% respectively (Table 1). Highest NPU_a was found for T₃, which contained lowest amount of feed compared to other treatments. Significant difference was found between T₃ and other experimental groups. The net protein utilization increased with increasing restriction of feeding.

Gross and net production: The gross production in T₁, T₂ and T₃ was 299±15.22, 287±42.94 and 274±22.78 kg/ha respectively. While, net production in T₁, T₂ and T₃ was 280±14.27, 270±40.34 and 260±21.60 kg/ha respectively (Table 1). However, no significant difference was observed for gross and net production among the experimental groups.

Table 1: Growth performance and feed utilization of *M. rosenbergii* in different experimental groups. Similar alphabet along the row indicates no significant ($p < 0.05$) difference.

<i>Parameters</i>	<i>T₁ (control)</i>	<i>T₂</i>	<i>T₃</i>
Final weight (g)	16.14±8.2 ^a	16.56±1.57 ^a	19.33±7.75 ^b
Weight gain (g)	15.14±8.2 ^a	15.56±1.57 ^a	18.33±7.75 ^b
Final Length (cm)	11.7±2.04 ^a	11.8±1.57 ^a	12.40±1.51 ^b
DWG (g/day)	0.15±0.08 ^a	0.16±0.02 ^a	0.18±0.08 ^b
SGR (%BW/day)	2.67±0.46 ^a	2.72±0.42 ^a	2.89±0.40 ^b
Survival rate (%)	93±4.7 ^a	87±12.96 ^a	71±5.89 ^b
FCR	1.49±0.1 ^a	1.16±0.13 ^b	0.81±0.08 ^c
PER	2.23±0.28 ^a	2.86±0.19 ^a	4.13±0.25 ^b
NPU _a (%)	42.80±11.23 ^a	51.32±8.45 ^a	87.75±13.43 ^b
Gross production (kg/ha)	299±15.22 ^a	287±42.94 ^a	274±22.78 ^a
Net production (kg/ha)	280±14.27 ^a	270±40.34 ^a	260±21.60 ^a

Water quality parameters: In the present study, important water quality parameters, like pH, temperature, dissolved oxygen (DO), alkalinity, hardness, ammonia salinity were monitored. No significant difference was found among the treatments for the parameters. All water quality parameters were within the acceptable range for freshwater prawn culture (Table 2).

Table 2: Mean±SD values and ranges of water quality parameters in different experimental groups

<i>Water quality Parameters</i>	<i>Experimental groups</i>		
	<i>T₁</i>	<i>T₂</i>	<i>T₃</i>
Temperature (°C)	27.31±4.53	27.21±4.48	27.37±4.34
DO (mg/L)	4.90±0.67	5.09±0.70	5.03±0.67
pH	7.58±0.17	7.62±0.17	7.66±0.18
Ammonia (mg/L)	0.19±0.1	0.17±0.13	0.12±0.04
Salinity (ppt)	0.53±0.32	0.59±0.21	0.56±0.23
Alkalinity (CaCO ₃ mg/L)	211.51±40.95	215.48±37.13	176.19±41.33
Hardness (CaCO ₃ mg/L)	224.92±128.3	216.98±101.29	253.65±102.78

Discussion

Feed is the major operational cost in prawn and shrimp aquaculture systems, a concern of farmers is not to overfeed the cultured animals (Tan and Dominy, 1997). Any reduction of allocated feed to farm raised prawn could bring economic savings in commercial farms. Moreover, it is a matter of doubts on what level of reduction of feeding rates could be

undertaken without hampering prawn growth. In the present study, the average growth of prawn was statistically higher in T₃ with 50% reduction of the artificial feed than control (prawn fed at satiation). This study partially supports the study of Nunes *et al.* (2006) where the growth of shrimp fed to apparent satiation (control) and a restriction of 25% and 50% showed no significant differences. Nunes *et al.* (2006) performed their study in indoor tank culture system where no natural food was used and the source of nutrients came only from the supplemental feed. In the present study, the prawn was reared in pond culture system where prawn got nutrition from both the natural and artificial sources. Porchas *et al.* (2012) found 68% of natural food consumption and 32% of artificial food consumption in natural productivity (phytoplankton, zooplankton, benthic fauna) enhanced ponds (by fertilizers) whereas in unenhanced pond, shrimp consumed 58% of formulated feed and 42% of natural food. In the present study, the final body weight of prawn fed at apparent satiation and a restriction of 25% of feed did not differ significantly. These results suggest that prawn fed to apparent satiation were overfed and, some feed restriction would be possible (Nunes *et al.*, 2006). The SGR and DWG were significantly high in T₃ than other treatments of this study. This might be due to the high growth rate in T₃ as the survival rate was low at final harvesting, so the competition for consuming feed might be low. The survival rate of prawn was significantly lower in T₃ than other groups. In pond culture system without shelter, prawn might be attacked by other prawn during moulting as prawn/shrimp show cannibalistic behavior. As the restriction of feeding was more in T₃, prawn may not find sufficient feed as early stage and might be attacked by other individuals. While growing, the prawn could get more feed due to the lower survival rate and could find more natural food which has a great impact on the growth rate of prawn. Nunes *et al.* (2006) found no significant difference for survival rate between shrimp fed at satiation and upto 50% reduction of feed. But, a feed reduction of 75% over the shrimp's apparent satiation was very severe and the survival rate was significantly low. In the present study, the FCR decreased with increasing feeding restriction and T₃ showed lowest FCR which was statistically significant. Generally, the maximum utilization of feed occurred above the maintenance feeding level but below the satiation or maximum feeding level (Eroldogan *et al.* 2004; Rowland *et al.* 2005) and the best feed conversion efficiencies are attained below satiation (Zoccarato *et al.* 1994; Van Ham *et al.* 2003; Eroldogan *et al.* 2004). More feeding causes overload of stomach and intestine resulting in low digestion and absorption of feed which increased FCR (Jobling, 1986; Storebakken and Austreng, 1987a). In the present experiment, T₃ showed the highest PER value and lowest FCR value due to the better utilization of feed. The apparent net protein utilization (NPU_a) increased with increasing feeding restriction and T₃ showed highest NPU_a which was statistically significant. The increased net protein utilization and increased protein efficiency ratio with restricted feeding was due to the increased apparent digestibility and retention of protein in the tissue of prawn. It has been reported that protein utilization and loss of nitrogen decreased with increasing feeding level (Du *et al.*, 2006; Ballestrazzi *et al.*, 1998; Storebakken and Austreng, 1987a). Though the average final weight was high in T₃, the average gross and net production was not statistically significant because of the survival rate. The survival rate in T₃ was lowest, so the production was not statistically significant. On the other hand, the culture period was only for 100 days, the prawn did not reach the marketable size resulted low production. Water quality parameters were within the culturable range reported by

different authors (Fair and Foftner, 1981; New, 2002; FAO, 2001; Hossain *et al.*, 2000; Jia-Mo *et al.*, 1988; Ali *et al.*, 1982; FAO, 2015; New, 1995; Wetzel, 2001; Wickins, 1972) and no significant difference was found. In the present study, the average final growth, PER and NPU_a increased with feeding restriction while FCR decreased with restriction of feeding which is a good indication for the better utilization of feed.

Conclusion

The growth rate of prawn increased significantly in treatment (T₃) where 50% restriction of artificial feed was applied. There was a significant effect of restricted feeding on survival rate of prawn and T₃ showed the lowest survival rate. The feed conversion efficiency (FCR) decreased significantly with increasing restriction of feeding. The protein efficiency ratio (PER) and net apparent protein utilization (NPU_a) was increased with increasing feeding restriction due to the better utilization of feed. To get better result this type of experiment should be extended upto marketable size of prawn.

Acknowledgement

The authors acknowledge *Khulna University Research Cell* for financial support and sincere cooperation during the research period.

References

- Ahmed, N., Demaine, H., & Muir, J. F. (2008). Freshwater prawn farming in Bangladesh: history, present status and future prospects. *Aquaculture Research*, 39(8), 806-819.
- Ali, M., Nicieza, A., & Wootton, R. J. (2003). Compensatory growth in fishes: a response to growth depression. *Fish and fisheries*, 4(2), 147-190.
- Ali, S. (1982). Studies on the diurnal variation in physico-chemical factors and zooplankton in a fresh water pond. *Bangladesh Journal of Fisheries*, 2(1), 15-23.
- AOAC. (1980). Official methods of analysis. Association of official analytical chemists, (ed. W. Horwitz) 13th edition, Washington DC, 988 pp
- APHA (American Public Health Association), 1976. Standard Methods for the Examination of Water and Wastewater. 14th Edition, American Public Health Association, Washington DC, 1193.
- Ballestrazzi, R., Lanari, D., & D' Agaro, E. (1998). Performance, nutrient retention efficiency, total ammonia and reactive phosphorus excretion of growing European sea-bass (*Dicentrarchus labrax*, L.) as affected by diet processing and feeding level. *Aquaculture*, 161(1), 55-65.
- Boyd, C. E., & Tucker, C. S. (2012). *Pond aquaculture water quality management*. Springer Science & Business Media.
- Chanratchakool, P., Limsuwan, C., & Turnbull, J. F. (1994). Health management in shrimp ponds. Aquatic Animal Health Research Institute
- Du, Z. Y., Liu, Y. J., Tian, L. X., He, J. G., Cao, J. M., & Liang, G. Y. (2006). The influence of feeding rate on growth, feed efficiency and body composition of

- juvenile grass carp (Ctenopharyngodonidella). *Aquaculture International*, 14(3), 247-257.
- Enriquez, F. (2003). Variación del bentos, con énfasis en la comunidad de poliquetos en unalaguna de descarga de unagranjacamaronícola. *Variación del bentos, con énfasis en la comunidad de poliquetos en unalaguna de descarga de unagranjacamaronícola*.
- Eroldoğan, O. T., Kumlu, M., & Aktaş, M. (2004). Optimum feeding rates for European sea bass *Dicentrarchus labrax* L. reared in seawater and freshwater. *Aquaculture*, 231(1), 501-515.
- Eroldoğan, O. T., Kumlu, M., Kiris, G. A., & Sezer, B. (2006). Compensatory growth response of *Sparus aurata* following different starvation and refeeding protocols. *Aquaculture Nutrition*, 12(3), 203-210.
- Fair, P. H., & Fortner, A. R. (1981). The role of formula feeds and natural productivity in culture of the prawn, *Macrobrachium rosenbergii*. *Aquaculture*, 24, 233-243.
- FAO, (2001). Report of a joint FAO expert consultation on evaluation of health and nutritional properties of probiotics in food including powder milk live lactic acid bacteria. Cordova, Argentina.
- FAO, (2015). FAO corporate document repository. Shrimp culture: pond design, operation and management. Source:
<<http://www.fao.org/docrep/field/003/ac210e/AC210E09.htm>>
Accessed on January 8, 2015
- Hossain, M. A., Siddique, M. A. L., & Miaje, M. A. H. (2000). Development of low-cost feed for culture of giant freshwater prawn (*Macrobrachium rosenbergii* de Man) in ponds. *Bangladesh Journal of Fisheries Research*, 4(2), 127-134.
- Jia-Mo, P., Zhi-Guo, L., Zi-Hao, Y., Martinez-Silva, L. E., Osorio-Dualiby, D., & Torres-Virviescas, M. (1988). The intensive culture of freshwater prawn *Macrobrachium rosenbergii* (de Man). *Trianea*, 1, 45-55.
- Jobling, M. (1986). Gastrointestinal overload—a problem with formulated feeds? *Aquaculture*, 51(3-4), 257-263.
- Jory, D. (2000). SHRIMP General Concerns For Management Of In-Progress Shrimp Ponds. *Aquaculture Magazine-Arkansas*, 26(4), 76-80.
- Lovell, T. (1998). Feeding tilapias. In *Nutrition and Feeding of Fish* (pp. 215-225). Springer, Boston, MA.
- Millamena, O. M. (1990). Organic pollution resulting from excess feed and metabolite build-up: effect on *Penaemonodon* postlarvae. *Aquacultural engineering*, 9(3), 143-150.
- New, M. B. (1995). Status of freshwater prawn farming: a review. *Aquaculture research*, 26(1), 1-54.
- New, M. B. (2002). *Farming freshwater prawns: a manual for the culture of the giant river prawn (Macrobrachium rosenbergii)* (No. 428). Food & Agriculture Org..
- Nunes, A. J. P. (2004). Use of feeding trays in Brazilian shrimp farming. *Aqua Feeds: Formulation and Beyond*, 1, 14-18.

- Nunes, A. J., Sá, M. V., Carvalho, E. A., & Neto, H. S. (2006). Growth performance of the white shrimp *Litopenaeus vannamei* reared under time- and rate-restriction feeding regimes in a controlled culture system. *Aquaculture*, 253(1), 646-652.
- Porchas-Cornejo, M. A., Martínez-Porchas, M., Martínez-Córdova, L. R., Ramos-Trujillo, L., & Barraza-Guardado, R. (2012). Consumption of natural and artificial foods by shrimp (*Litopenaeus vannamei*) reared in ponds with and without enhancement of natural productivity. *Isr. J. Aquacult.-Bamidgeh.*, IJA-64.2012, 709(7).
- Primavera, J. H. (1993). A critical review of shrimp pond culture in the Philippines. *Reviews in Fisheries Science*, 1(2), 151-201.
- Rowland, S. J., Allan, G. L., Mifsud, C., Nixon, M., Boyd, P., & Glendenning, D. (2005). Development of a feeding strategy for silver perch, *Bidyanus bidyanus* (Mitchell), based on restricted rations. *Aquaculture Research*, 36(14), 1429-1441.
- Storebakken, T., & Austreng, E. (1987). Ration level for salmonids: I. Growth, survival, body composition, and feed conversion in Atlantic salmon fry and fingerlings. *Aquaculture*, 60(3-4), 189-206.
- Tacon, A. G. (2002). Thematic review of feeds and feed management practices in shrimp aquaculture. *Report prepared under the World Bank, NACA, WWF and FAO consortium program on shrimp farming and the environment. Work in progress for public discussion. Published by the Consortium*, 69.
- Tan, R. K. H., & Dominy, W. G. (1997). Commercial pelleting of crustacean feeds. *Crustacean Nutrition. Advances in World Aquaculture*, 6, 520-549.
- Van Ham, E. H., Berntsen, M. H., Imsland, A. K., Parpoura, A. C., Bonga, S. E. W., & Stefansson, S. O. (2003). The influence of temperature and ration on growth, feed conversion, body composition and nutrient retention of juvenile turbot (*Scophthalmus maximus*). *Aquaculture*, 217(1), 547-558.
- Wahab, M. A., Ahmad- Al- Nahid, S., Ahmed, N., Haque, M. M., & Karim, M. (2012). Current status and prospects of farming the giant river prawn *Macrobrachium rosenbergii* (De Man) in Bangladesh. *Aquaculture Research*, 43(7), 970-983.
- Wetzel, J. E. (2001). A production methods for freshwater prawn in Illinois ponds. rural enterprise and alternative development initiative report. *Report*, 10, 1.
- Wickins, J. F. (1972). Experiments on the culture of the spot prawn *Pandalus platyceros* Brandt and the giant freshwater prawn *Macrobrachium rosenbergii* (de Man).
- Zoccarato, I., Benatti, G., Bianchini, M. L., Boccignone, M., Conti, A., Napolitano, R., & Palmegiano, G. B. (1994). Differences in performance, flesh composition and water output quality in relation to density and feeding levels in rainbow trout, *Oncorhynchus mykiss* (Walbaum), farming. *Aquaculture Research*, 25(6), 639-647.