J. Environ. Sci. & Natural Resources, **9(1): 109-116, 2016** ISSN 1999-7361

Comparison of Performance between Organic Farming and Traditional Farming of Freshwater Prawn in Respect of Production and Economics

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Abstract

An experiment was conducted to compare the performance between traditional farming and organic farming of freshwater prawn in respect of production and economics. The experiment had two treatments, namely: Traditional (TT) and Organic (TO) with same stocking density (20000 juvenile's ha^{-1}) in triplicate. In treatment TO, formulated feed with locally available ingredients were used, and maize flour and bamboo branches were provided for maintaining C:N ratio to 20 and for developing periphyton, respectively. In treatment TT, only commercially available prawn feed was applied. No fertilizers or other types of chemicals or antibiotics were used in both treatments. There were no significant differences ($P>0.05$) of different water quality parameters between both treatments. Weight gain and specific growth rate (% body weight day^{-1}) of prawn was significantly higher ($P<0.05$) in TO than TT treatment. Survival rate and feed conversion ratio of prawn did not vary significantly between both treatments. Highest total yield was obtained from TO treatment (511.41 kg ha^{-1} 90 d^{-1}) compared to TT treatment (426.57 kg ha^{-1} 90 d^{-1}). Net yield was also significantly higher in treatment TO (428.32 kg ha^{-1} 90 d^{-1}) than TT (347.77 kg ha^{-1} 90^{-1}). Although there was no significant difference in benefit-cost ratio between both treatments, totalreturn was significantly higher in TO than TT treatment.

Key word: Freshwater prawn, *Macrobrachium rosenbergii,* Organic farming, Production, Traditional farming

Introduction

Freshwater prawn has been appeared as a major aquaculture species in many countries including China, India, Indonesia, Vietnam, Bangladesh and Equador after its domestication in 1960s (Fatema *et al.*, 2011). Bangladesh is considered as one of the most suitable countries for giant freshwater prawn (*Macrobrachium rossenbergii*) farming, because of its favorable agro-climatic condition. Bangladesh has entered into the commercial prawn farming in early 1990s and has become a world player as one of the seven major export countries (Wahab, 2009) .Due to favorable climate, abundant low lying rice fields, availability of seeds and other water resources, Bangladesh can now dream to be a dominant producer after China and India. There is a difference between organic farming and traditional farming of prawn. The increase in world aquaculture production has recently seen the negative impacts of unsustainable production methods in many countries with regard to the environment and in some cases, consumer's safety. Traditional and unplanned prawn culture has serious impact on the environment. Due to increase awareness, in many European Union countries, consumers are becoming more anxious about the food they eat and are increasingly concerned with food production issues such as food safety (Haung, 1995), food quality (Haglund *et al.* 1999), and animal welfare (Fearne and Lavelle, 1996). Consumers of developed countries are turning their interest to the organically produced aquatic products. Therefore, countries like Vietnam, Thailand, Indonesia, and Ecuador have quickly responded to the demands of the export markets and converted their culture system for growing organic shrimp and began to penetrate these markets with their goods. In the late 1990s, in response to the negative environmental and social consequences of modern farming methods, the world's first organic shrimp farm was created in Ecuador. Bangladesh and other South Asian countries are still far behind to catch up the growing organic markets. Moreover, demand for organic fish and shellfish is also expected to grow in the Asian markets. Thus, Bangladesh urgently needs to promote organic aquaculture for expanding the present export market.

Organic farming protects the health of consumers by reducing the overall exposure to toxic chemicals from pesticides that can accumulate in the ground, air, water and food supply. Organic prawn farming is an important way of moving towards the goal of sustainability. Moreover, sustainable prawn farming will not only help to ensure that resources are recycled and maintained but also overseas market access is improved, as consumers increasingly demand that food be produced in an environmentally sustainable system. Organic prawn can contribute to increased export and domestic market earning by supplying a particular market niche with a product perceived as high quality by environmentally aware consumers. Organic prawns provide a recognizable alternative for those consumers seeking food with little or no chemical residues.

The use of periphyton substrates and manipulation of C:N ratio as an approach of organic culture in freshwater prawn production has been found promising. These techniques require installation of hard substrates or application of cheap carbohydrates which could potentially be produced within the farmers' traditional systems. Substrates based system can increase freshwater prawn production to a significantly higher level when compared to traditional production system (Tidwell and Bratvold, 2005). Cohen *et al.* (1983) reported that added substrate in ponds increased prawn production by 14% and average size by 13%. Experiments conducted in Bangladesh showed that vertical substrate addition resulted in prawn survival increased 75% and production 127% prawn in -tilapia polyculture system (Uddin *et al.,* 2006). The benefits exerted from periphyton-based ponds are periphyton as additional natural food, substrate as shelter to minimize territorial effects and improved water quality through trapping suspended solids, organic matter breakdown and enhanced nitrification. On the other hand, prawn is fed with a specially formulated organic food which contains no drugs and has locally available low cost raw materials free from GM and artificial chemicals and a high C:N ratio is maintained by using low cost maize flour.

Trials with periphyton-based aquaculture in freshwater ponds in Benin, West Africa gave significantly higher annual fish yields, as compared with production from other rural ponds managed for aquaculture (Hem *et al.*, 1994). Consequently, this innovative pond management strategy was proposed as a suitable technique to increase fish production in rural ponds in South Asia, particularly in Bangladesh and India. Enhancement of periphyton by providing artificial substrates in the aquaculture systems is a simple and may be a cheaper way to increase production. It is an efficient way of producing fish as the food chain is reduced to one trophic level and the energy losses are minimized.

Considering the importance of organic farming by periphyton-based systems and manipulating the C:N ratio in organic feed for culture of freshwater prawn, and paucity of information of previous works, the present study was designed to compare the performance between organic farming and the traditional farming of freshwater prawn in respect of production and economics. The ultimate objective of this experiment was to establish an organic farming method of freshwater prawn in a cost effective way. If the organic farming method of prawn is found better in respect of production and economics through this experiment, it can be followed by the prawn farmers of Bangladesh so that present export markets would be expanded.

Materials and Methods

Experimental design

The experiment was conducted using a completely randomized block design into two treatments with three replications for each. Stocking density of prawn juvenile was same in both treatments (Table 3.1). The differences between both treatments were in the management practices. The treatments were traditional and organic farming of prawn. The treatment of traditional farming is abbreviated as TT and the organic farming as TO.

In treatment TO, formulated feed with the locally available ingredients was used, and maize flour and bamboo *kanchi* were provided for maintaining C:N ratio 20 and developing periphyton, respectively. But in treatment TT, commercially available prawn feed was applied, and maize flour and bamboo branches (*kanchi*) were not supplied. Rotenone, lime and fertilizer were used only during the preparation of ponds but no fertilizers or other types of chemicals or antibiotics were used in both treatments after stocking.

Table 1. Experimental design

Variables	Treatments (Stocking density /ha)	
	TT	TO
Freshwater prawn	20,000	20,000
Feed	Commercial	Locally formulated

Experimental site and pond preparation

The experiment was carried out at the pond facilities of Fisheries Field Laboratory of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh for a period of 90 days from 31 August to 28 November 2009. Six rectangular earthen ponds with an area of 130 m^2 and an average depth of 1.2 m each were used for this research. The ponds were rain-fed, well exposed to prevailing sunlight and being used for research over last 20 years. All unwanted fishes were eradicated by rotenone application at the rate of 100 g $pond^{-1}$. Lime ($CaCO_3$) was applied to all ponds at the rate of 250 kg ha^{-1} on Day 1.

On day 4, ponds were filled with groundwater from a deep tube-well. On day 6, 12 side shoots of bamboo (locally known as *kanchi*) per m^2 water surface area with a mean diameter of 2.8 cm were posted vertically into the bottom mud in TO ponds, excluding a 0.5 meter wide free perimeter. This resulted in an additional substrates surface area of 40 m^2 for periphyton development equaling 60% of the pond surface area. On day 9, all ponds were fertilized with urea and triple super phosphate (TSP) at the rates of 100 and 100 kg ha^{-1}, respectively. Ponds were left for 10 days post-fertilization to allow plankton development in the water column and periphyton growth on substrates (treatment TO), and subsequently stocked with prawns.

Stocking and pond management

In all ponds, post larvae (PL) of freshwater prawn (individual weight 5.47 ± 0.02 g) procured from a nearby commercial hatchery was stocked according to the experimental design (2 prawns m^{-2}). No fertilizers were used after stocking in both treatments.

In case of treatment TO, a locally formulated and prepared pellet feed (2 mm) containing about 24% protein (% dry matter basis) with a C/N ratio close to 15:1 was used. The feed was applied considering the body weight of prawn at a daily feeding rate of 10% body weight at the start of experiment, and gradually reduced to 5% body weight at the end of the culture period. Feed was distributed evenly over the pond’s surface, twice daily at 7.00 to 18.00 hours. Individual weights of minimum 10% of initially stocked prawn in numbers were taken at monthly interval to estimate the biomass and adjust the feeding rate. Prawns were sampled using a cast net in both treatments but in treatment TO, it was done after eliminating some bamboo *kanchi*, which were re-positioned after the sampling.

In treatment TO, locally purchased maize flour was used as carbohydrate source for manipulating the C/N ratio to 20:1. The analysed proximate composition of feed and maize flour is given in Table 2. The pre-weighed maize flour was mixed with pond water in a beaker and evenly distributed over the pond surface directly after the application of feed at 07:00 and 18:00 hours.

Table 2. Proximate composition of the prepared feed and maize (percentages are given on dry weight basis)

Component	Dry matter (%)	Protein (%)	Lipid (%)	Fiber (%)	Ash (%)	Carbohydrate (%)
Prepared feed	91.31	24.27	10.00	6.15	20.61	30.28
Maize flour	88.92	7.72	4.64	5.40	1.14	70.02

Determination of water quality parameters

Water samples were collected using a horizontal water sampler from three locations of each pond. Water quality parameters, temperature (degree Celsius, thermometer), dissolved oxygen (HACH Sension 8), pH (CORNING 445 pH meter) and transparency (Secchi disc) were monitored in situ at 0900 h on a weekly interval. Total alkalinity (titrimetric method) and nutrients, NO_2-N, NO_3-N, NH_3-N and PO_4-P concentrations (HACH kit model DR 2010) were determined in the late morning (between 0900 to 1000 h) at monthly basis (APHA, 1992).

Before nutrient analysis, water samples were filtered through a glass microfibre filter paper (Whatman GF/C, Whatman International, Maidstone, England) using a vacuum pressure air pump. The filter papers containing particulate matter were preserved in 10 ml of 90% acetone in a test tube and kept in refrigerator for 24 hours for subsequent chlorophyll *a* analysis. The papers in the test tube were ground by using a glass rod, centrifuged (Denlay centrifuge, model BS-400) for 10 minutes at 3,000 rpm and made ready for chlorophyll *a* analysis. Afterward, supernatant water was poured to a cuvette and chlorophyll *a* was determined using spectrophotometer (Spectronic Genesys 5, model 336001) at 664 and 750 nm wave lengths, following Boyd (1979).

Assessment of plankton population

Plankton samples were collected monthly by pooling 10 Liter of water from five locations in each pond and passing it through a plankton net (mesh size 45 µm). The concentrated samples were preserved in small plastic bottles with 5% buffered formalin.

Plankton numbers were estimated using a Sedgewick-Rafter (S-R) cell and was left to stand for 15 minutes to allow plankton to settle. Then, the planktons on 10 randomly selected fields of the chamber were counted under a binocular microscope (Swift, M-4000). Taxa were identified to genus level using keys from Bellinger (1992). Plankton abundance was calculated using the following formula (Azim *et al*., 2001):

$$N = (P \times C \times 100)/L$$

Where, *N* is the number of plankton cells or units per liter of original water; *P*, the number of plankton counted in 10 fields; *C*, the volume of final concentrate of the sample (ml); *L*, the volume (L) of the pond water sample.

Assessment of benthic macroinvertebrates

The benthic invertebrate samples from the pond bottom muds were collected monthly using an Ekman dredge (area 225 cm^2 at the lower mouth). The mud samples were taken randomly from three different locations in each pond and washed through a sieve (250 µm mesh size). Benthic invertebrates remaining on the sieve were separated and preserved in a plastic vial containing 10% buffered formalin solution. Identification keys used for benthic macroinvertebrates were from Pinder and Reiss (1983). Benthic macroinvertebrates density (individuals/m^2) were calculated using the following g formula (Asaduzzman *et al*., 2010):

$$N = Y \times 10000 / 3A$$

Where, N = number of benthic organisms (number m^{-2}); Y = total number of benthic organisms counted in 3 samples; A = area of Ekman dredge (cm^2).

Taxonomic composition and biomass of periphyton

From each pond, three *kanchi* poles were selected randomly and three 2×2 cm samples of periphyton were taken at each of three depths (25, 50 and 75 cm below from the water surface) per pole at monthly interval starting after 7 days of substrate installation. One of the three samples from three poles and three depths per pond per sampling day were pooled for dry matter (DM), ash and ash free dry matter (AFDM) analysis.

The other two pooled samples from three poles and three depths were employed for chlorophyll *a* determination and taxonomic identification. Periphyton biomass and autotrophic index were analyzed following APHA (1992). Periphytic algae were calculated using a binocular microscope (Olympus, M-4000D, Tokyo, Japan) as described by Azim *et al.* (2001).

Harvesting of prawn and estimation of yield parameters

Prawns were harvested after draining the ponds. Individual length (wooden measuring board; precision

0.1cm) and individual weight (Denver-xp-3000; precision=0.1g) were recorded. Specific growth rate (SGR), feed conversion ratio (FCR) and net yields were calculated as follows:

SGR (% bw day^{-1}) = [(ln final weight – ln initial weight) x 100]/ Culture periods (days)
FCR = Feed applied (dry weight) /Live weight gain
Net yield = Total biomass at harvest – Total biomass at stocking

Economic analysis
An economical analysis was performed to estimate the net return and benefit-cost ratio in both treatments. The following equation was used:

R = I – (FC + VC + Ii)

Where, R = net return, I = income from prawn and tilapia sale, FC = fixed/common costs, VC = variable costs and Ii = interest on inputs. The benefit cost ratio was determined by following equation:

Benefit cost ratio (BCR) = Total net return / Total input cost

The wholesale prices per kg of large, medium and small prawn were TK. 450, 300 and 200, respectively. The prices of inputs and prawn correspond to the Mymensingh wholesale market prices in July to December 2009 and are expressed in Bangladeshi taka (1US$ = 70 BDT).

Statistical analysis
Independent samples T-Test was performed for comparing water quality parameters, plankton, periphyton and benthic macorinvertibrates data, and growth and production of prawn and tilapias as well as economics between both treatments. Survival and percent data were analyzed using arcsine-transformed data, but percent values were reported. The assumptions of normal distribution and homogeneity of variances were checked before analysis. All statistical tests were carried out at a 5% level of significance using SPSS (Statistical Package for Social Science) version 16.0

Results and Discussion

Water quality parameters
In fish culture, water quality is usually defined as the suitability of water for the survival and growth of fish. Mean values of water quality parameters did not differ significantly (P>0.05) between two treatments (Table 2). The mean values of water temperature were more or less close to the 27ºC in each treatment. The recommended suitable range of temperature for prawn culture is 21.9ºC to 33.5ºC (Fair and Foftner, 1981).

Water transparency indicating sestonic food abundance found to be ranged from 23 to 61cm in two treatments which were more or less similar with the findings of Kohinoor *et al*. (2001); Uddin (2002) who recorded values ranging from 15 to 58 cm and 11 to 63.5 cm. The ranges of dissolved oxygen concentration (2.30 to 9.20 mgL^{-1}) in two treatments exceeded the upper limit of the findings of Haque *et al* (2013) who recorded DO concentration 1.60 to 8.60 mgl^{-1}. Wulff (1982) reported that juveniles of freshwater prawn could tolerate minimum oxygen levels of 1.0 to 1.5 mg l^{-1} and suggested not to allow the prawns at such levels for long time. The mean values of pH were 7.37 ± 0. 05 and 7.28 ± 0.04 in treatments T_1 and T_2 respectively, which was more or less similar to the findings of Boyd and Zimmermann (1998), who reported that the ideal environment for nursing of prawn post-larvae should have pH values of 7 to 8.5. It is also reported that pH ranged from 6.8 to 8.4 is suitable for *Macrobrachium rosenbergii* culture (Hossain *et al*., 2000). Water bodies having total alkalinity 40 ppm or more are considered more productive than water bodies of lower alkalinity (Mairs, 1966).

According to Boyd (1982) total alkalinity should be more than 20 ppm in fertilized ponds. Total alkalinity in the present study ranged from 74.00 to 120.00 mg l^{-1} in both treatments, indicating that total alkalinity in the present experiment might be considered as a suitable range for fish culture. The mean (±SE) values of chlorophyll *a* were more or less identical to the findings of Haque *et al.* (2013) but were lower compared to the findings of other authors in this region (Kadir *et al.*, 2006; Milstein *et al.*, 2006; Kunda, 2008; Rahman *et al.*, 2010b;) might be due to lower values of total nitrogen limiting the algal biomass (Maclean *et al*., 1994).

The values of NH_3-N in treatment T_1 and T_2 were 0.08 to 1.03 mg l^{-1} and 0.01 to 0.56 mg l^{-1} which are more or less similar to Rahman (2005) and Asaduzzaman *et al.* (2006) who recorded ammonia-nitrogen value ranged from 0.01 to 0.82 and 0.203 to 0.569 mg l^{-1}, respectively. The ranges of NO_3-N were found to varied from0.010 to 0.06 mg l^{-1} and 0.020 to 0.06 mg l^{-1} in T_1 and T_2 treatments, respectively which are more or less similar to the finding of Asaduzzaman *et al*. (2005) and Haque *et al.* (2013). The mean (± SE) values of NO_2-N concentration were 0.004 ± 0.005 mgl^{-1} and 0.003 ± 0.005 mg l^{-1} in T_1 and T_2 treatments, respectively which are comparable to the findings of Azim *et al*., (1995); Wahab *et al*. (1995); Haque *et al.* (2013)

Phosphate-phosphorous (mg l^{-1}) were found to vary from 0.17 to 0.89 mg l^{-1} and 0.13 to 0.59 mg l^{-1} during the experiment in T_1 and T_2 treatments, respectively which are more or less agree with the findings of Wahab *et al.* (1995), Uddin (2002) and Alim (2005) who recorded phosphate-phosphorus values ranging from 0.09 mg l^{-1} to 5.2 mg l^{-1}, 0.03 mg l^{-1} to 4.46 mg l^{-1}, respectively. The concentration of chlorophyll *a* was found to vary from 7.14-82.85 µg l^{-1} and 11.90-43.70 µg l^{-1} during the experiment in T_1 and T_2 treatments, respectively which were more or less similar to Hasan (1998); Paul (1998) who found chlorophyll *a* in pond waters range from 10 to 200 µg l^{-1}.

Abundance of plankton and benthic macro-invertebrates

The abundance of plankton and benthic macro-invertebrates in the culture system are influenced by a number of management factors. Among them fish species combinations in polyculture, stocking density and ratio, and the nutrient input quality and quantity are most important (Milstein, 1993; Diana *et al*., 1997).

Table 3. Mean (±SE) values of measured water quality parameters

Parameters	Treatments		Level of Significance at 5%
	T_1	T_2	
Temperature surface (^oC)	27.48 ± 0.51	27.33 ± 0.52	
Temperature bottom (^oC)	26.20 ± 0.40	26.14 ± 0.40	NS
Transparency (cm)	43.31 ± 1.15	42.02 ± 1.61	NS
pH range	7.37 ± 0.05	7.28 ± 0.04	NS
Dissolved oxygen (mg l^{-1})	4.66 ± 0.21	4.52 ± 0.22	NS
Total Alkalinity	102.0 ± 2.66	99.42 ± 3.21	NS
Total NH_3-N (mg l^{-1})	0.16 ± 0.04	0.19 ± 0.04	NS
NO_3-N (mgl^{-1})	0.018 ± 0.003	0.018 ± 0.004	NS
NO_2-N (mgl^{-1})	0.004 ± 0.005	0.003 ± 0.006	NS
PO_4-P (mgl^{-1})	0.43 ± 0.06	0.33 ± 0.04	NS
Chlorophyll *a* (µg l^{-1})	36.57 ± 6.62	22.72 ± 2.40	NS

NS= Means are not significantly different (P> 0.05)

Apart from these management factors, fish feeding habits have an important influence on the abundance of plankton and benthos, both directly by consumption and indirectly through influencing the food web and nutrient availability. The phytoplankton species composition identified in the present experiment was representative of that found in Bangladesh prawn farming in rice fields and ponds (Wahab *et al*., 2008; Kunda *et al*., 2008; Uddin, 2007). The more abundance of plankton in TO ponds then TT ponds may be due to the use of maize flour as CH source to maintain a high C/N ratio. The carbohydrates source may increase the nutrients content of the TO ponds which in turn may enhance the abundance of plankton. The observed increase in the abundance of plankton during the first two months might be due to the increased nutrients in both treatments. The decrease in abundance of plankton after the second month might be attributed to increased grazing pressure by prawn in the both treatments. The observed lowest abundance of Chironomidae, Oligochaeta and total benthic macroinvertebrate in TT ponds might indicate that prawn directly feed on this benthic fauna. More abundance of benthos in TO ponds then the TT ponds also observed. This may be due to the availability of periphyton in organic culture ponds which may influence a decreased grazing pressure on benthos. The observed decrease in number of benthos during the culture period might be due to increased grazing pressure by prawn (Asaduzzaman *et al*., 2009). There is evidence that prawns in their natural habitats prefer to forage on animals like trochopterans, chironomids, oligochaetes, nematodes, gastropods and zooplankton (Corbin *et al*., 1983; Coyle *et al*., 1996; Tidwell *et al*., 1997).

Periphyton biomass

The quantitative production of periphyton was determined as dry matter (DM), ash free dry matter (AFDM) and chlorophyll *a*. The periphyton biomass increase in the first month followed by a continuous decrease until the end of the experiment may be accounted for by changes in the prawn grazing pressure on periphyton. The low biomass of prawn initially exerted low grazing pressure allowing periphyton to grow. As prawn grew its increased grazing pressure led to reduced periphyton biomass.

Growth and production of prawn

There was no significant difference in the mean survival rate of prawn between both treatments. So, this may be concluded that, substrate and organic feed with high carbohydrate content has no effects on the survival rate of prawn. This may be agreed with the findings of Tidwell *et al.* (2002) who reported that, substrate had no significant (P>0.05) impact on prawn survival. The gross and net yields of prawn were significantly higher in treatment TO than treatment TT. It is hypothesized that the periphyton grown on bamboo surface was a readily available feed, which might have enhanced the growth and production rate of freshwater prawn in the ponds with substrates compared to that of the ponds having no substrates. This has been reflected in the higher weight gain of fish in the ponds having bamboo substrates (Wahab *et al*., 1999). This is mainly because of additional shelter and natural food in the form of periphyton colonized on bamboo substrates along with improvements of environmental conditions through a range of ecological and biological processes (Tidwell *et al.*, 2000; Tidwell *et al.*, 2002; van Dam *et al.*, 2002; Milstein *et al.*, 2003). Cohen *et al.* (1983) reported that added substrate in ponds increased prawn production by 14% and average size by 13%.

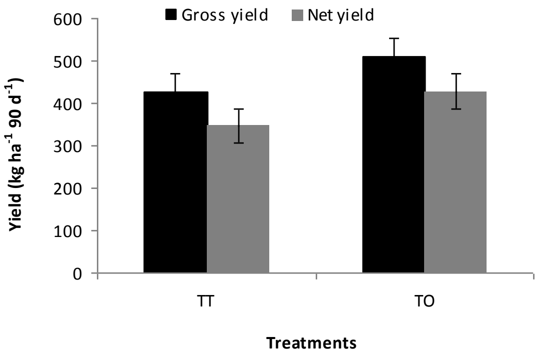

Fig. 1. Yield performance of freshwater prawn

Raanan *et al.* (1984) reported that added substrate was more effective in intensively stocked, aerated systems. However, pond ecological and growth data revealed that maize flour can be a good source of organic carbon to maintain a high C:N ratio for preparing organic feed. So, findings of the present study are agreed with the above authors.

Economics

The economic analysis revealed that the use of maize flour in organic feed reduced the carbohydrate cost thereby improved the economic benefits because the feed cost was 18% higher in treatment TT than treatment TO. Total return was 20% higher in treatment TO than TT. However, there was no significant difference in the net return between both treatments because substrate was an additional cost in TO. The economic benefit from TO may be increased further if the price rate of prawn from organic ponds might be increased in the export market due to the demand of organic products compared to the traditional products. On the other hand, market size of freshwater prawn should be at least 50 g which is not achieved in the present experiment due to short experimental periods.

Table 4. Abundance of plankton and benthos (mean ±SE, N=12) with their different groups recorded in two treatments

Variables	**Treatments**		**Level of Significance at 5%**
	T_1	**T_2**	
Plankton (x 10^3 cells or colonies)			
Bacillariophyceae	23.58 ± 1.39	31.38 ± 2.05	NS
Chlorophyceae	47.42 ± 2.34	53.00 ± 2.21	NS
Cyanophyceae	29.42 ± 2.37	24.92 ± 3.11	NS
Euglenophyceae	2.42 ± 0.58	2.42 ± 0.46	NS
Total phytoplankton	102.83 ± 4.01	111.70 ± 2.73	NS
Rotifera	3.33 ± 0.56	3.04 ± 0.31	NS
Crustacea	1.04 ± 0.22	0.75 ± 0.14	NS
Cladocera	6.21 ± 0.77	3.38 ± 0.53	NS
Total Zooplankton	12.96 ± 0.97	9.08 ± 0.65	NS
Total plankton	115.79 ± 4.30	120.79 ± 2.47	NS
Benthos (Individual m^{-2})			
Chironomidae	619.36 ± 35.74	682.80 ± 28.89	NS
Oligochaeta	225.80 ± 17.89	258.90 ± 23.69	NS
Mollusca	185.90 ± 10.85	199.73 ± 19.43	NS
Miscellaneous	68.70 ± 7.75	53.59 ± 5.03	NS
Total	1098.93 ± 62.9	1195.88 ± 66.02	NS

NS= Means are not significantly different (P> 0.05)

Table 5. Mean (±SE) values of periphyton quantitative parameters recorded from the sampling periods

Parameters	Sampling periods			
	Initial (August)	Period 1 (September)	Period 2 (October)	Period 3 (November)
DM (mg cm^{-2})	2.10±0.06	2.15±0.03	1.99±0.06	1.77±0.05
AFDM (mg cm^{-2})	1.40±0.05	1.45±0.02	1.37±0.03	1.29±0.02
Chlorophyll *a* (µg cm^{-2})	9.03±0.02	9.45±0.03	8.09±0.04	7.00±0.04

Table 6. Comparison of growth and production parameters (mean±SE, N=3) of prawn in two treatments during a 90-day culture period

Variables	Treatments	
	TT	TO
Individual stocking weight (g)	5.54 ± 0.02[a]	5.43 ± 0.01[b]
Individual harvesting weight(g)	29.98 ± 0.21[b]	33.67 ± 0.44[a]
Individual weight gain (g)	24.44 ± 0.19[b]	28.02 ± 0.43[a]
Specific growth rate (% bw d^{-1})	1.50 ± 0[b]	1.63 ± 0.01[a]
Feed conversion ratio	0.40 ± 0.02	0.36 ± 0.01
Survival (%)	71.15 ± 1.11	76.41 ± 1.68
Gross yield (kg ha^{-1} 90 d^{-1})		
Large (≥ 50g)	395.70 ± 5.93[b]	469.07 ± 16.99[a]
Medium (33.3-49.9g)	22.18 ± 2.32	31.97± 5.48
Small (≤ 33.2g)	8.69 ± 1.17	10.38 ± 1.00
Total	426.57 ± 6.84[b]	511.41 ± 12.72[a]
Net yield (kg ha^{-1} 90 d^{-1})	347.77 ± 5.69[b]	428.32 ± 11.29[a]

*Mean values with different superscripts indicate a significant difference (P<0.05)

Table 7. Comparison of economics (mean ± SE, N=3) of two treatments calculated on the basis of 1 ha pond and 90 days' experimental periods. Currencies are given in Bangladeshi Taka, BDT (1 US$ = 70 BDT)

Variables	Amount	Price rate	Treatments	
			TT	TO
(A) cost				
Land rental cost	1 ha	21000 $ha^{-1}y^{-1}$	6000±0	6000±0
Prawn juveniles	20000 ha^{-1}	4 $juvenile^{-1}$	80000±0	80000±0
Rotenone	12.5 kg	220 kg^{-1}	2750±0	2750±0
Lime	250 kg	10 kg^{-1}	2500±0	2500±0
Urea	100 kg	10 kg^{-1}	1000±0	1000±0
TSP	100 kg	25 kg^{-1}	2500±0	2500±0
Fuel cost	500 units	4 $unit^{-1}$	2000±0	2000±0
Substrates (reuse-5 times)	120000 P	1 $piece^{-1}$	0	24000±0
Labor		120 man^{-1} day^{-1}	4000±0	5000±0
Feed		25/20 kg^{-1}	41912.58±988.04[a]	35414.87±472.87[b]
Interest on inputs (4 months)		12% annually	5706.50±39.52	6446.60±18.91
Total cost (A)			148369.10±1027.56[b]	167611.50±491.78[a]
(B) Benefit (return)				
Prawn sale				
Large (≥ 50g)		450 kg^{-1}	178066.50±2669.03[b]	211080.00±7648.33[a]
Medium (33.3-49.9g)		300 kg^{-1}	6654.00±696.96	9591.00±1643.98
Small (≤ 33.2g)		200 kg^{-1}	1738.97±233.42	2076.67±198.14
Total benefit (B)			186459.20±2871.69[b]	222747.70±6274.17[a]
(C) Profit (B - A)			38090.08±3509.99	55136.21±5919.02
(D) Benefit cost ratio, BCR (B/A)			1.26±0.02	1.33±0.03

Mean values with different superscripts in each row indicate a significant difference (P<0.05).

Conclusions

Based on the findings of the present research, organic feed in addition of maize flour can be considered as a cheap diet. The findings of the present research confirmed that organic farming improved the natural food utilization efficiency and pond productivity. In the present study, it was not possible to estimate the contribution of artificial feed and different types of natural food to the growth of freshwater prawn. The result of the present study could be useful in improving the productivity of freshwater prawn in organic farming system. There exists scope for improvement of economic benefit of this technology by using other low cost feed ingredients and carbohydrate sources and cheaper on-farm periphyton substrates. The economic benefit from TO may be increased further if the price rate of prawn from organic ponds might be increased in the export market due to the demand of organic products compared to the traditional products. Moreover, further research is required for improvement of economic sustainability of organic farming.

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