Mud Crab *(Scylla serrata)* Fattening in Pen Culture System: Changes of Proximate Composition due to Fattening

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ID #2873
Received: 04/02/2018
In-revised: 30/10/2018
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KEYWORDS

Mud crab, Culture technique, Fattening, Proximate analysis.

ABSTRACT

The study was conducted to know the crab fattening in pen system and to evaluate the changes of proximate composition of mud crab due to fattening. After fattening, proximate composition was analyzed to assess the changes of nutritional value. The average survival rates of male and female crab were 64.722 ± 1.204% and 65.889 ± 0.701% respectively. The mean specific growth rate (SGR) was 1.245 ± 0.334% (male) and 0.976 ± 0.152% (female). The average value of FCR was 5.833 ± 0.119 and production rate was 0.4116 ± 0.095 kg/m2. Due to fattening, the moisture content of mud crab was decreased from 77.747 ± 0.705 to 75.551 ± 1.537% in male and from 75.030 ± 0.370 to 74.332 ± 0.202% in female. The mean crude protein content of the male mud crab *(Scylla serrata)* with shell was decreased but in case of female it was increased. The mean crude lipid content of mud crab was increased from 0.420 ± 0.110 % to 1.113 ± 0.102% and 1.093 ± 0.110 to 2.208 ± 0.204% respectively both of male and female. During fattening period the mean ash content was also increased in male and female. In addition the study showed that the mean crude fibre content also increased from 1.162 ± 0.089 to 1.613 ± 0.580% and 1.556 ± 0.367 to 1.884 ± 0.020% respectively in male and female. Furthermore nitrogen free extract content increased from 0.838 ± 0.064 to 0.982 ± 0.238% in male and from 1.251 ± 0.421 to 1.682 ± 0.640% in female. It was observed that all the nutritional compositions were changed due to fattening.

تسمين سلطعون الطين *(Scylla serrata)* في نظام التربية المغلقة: التغيرات في التركيبات بسبب التسمين

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رقم المسودة: (2873)
تاريخ استلام المسودة: 04/02/2018
تاريخ المسودة المُعَدّلة: 30/10/2018
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المُستلخص

أجريت الدراسة لمعرفة توسع السلطعون في نظام التربية المغلقة ولتقييم التغيرات في تكوين سرطان البحر بسبب التسمين. بعد التسمين ، تم تحليل التركيب التقريبي لتقدير التغيرات في القيمة الغذائية. بلغ متوسط معدلات البقاء على قيد الحياة من سرطان البحر من الذكور والإناث 64.722 ± 1.204 ٪ و 65.889 ± 0.701 ٪ على التوالي. وكان معدل النمو المحدد (ص٪0.334 ± 1.245 (GR (ذكور) و 0.976 ± ٪0.152 (أنثى). وبلغ متوسط قيمة FCR 5.833 ± 0.119 وكان معدل الإنتاج 0.4116 ± 0.095 كجم / م 2. نتيجة للتسمين، انخفض محتوى الرطوبة من سرطان البحر الطيني من 77.747 ± 0.705 إلى 75.551 ± 1.537٪ في الذكور ومن 75.030 ± 0.370 إلى 74.332 ± ٪0.202 في الإناث إنخفض محتوى البروتين الخام العادي من سرطان البحر الذكور (صچيللا سيرراتا) ولكن في حالة الإناث انخفض زادت. تم زيادة متوسط محتوى الدهون الخام في سرطان البحر من 0.420 ± ٪0.110 إلى 1.113 ± ٪0.102 و 1.093 ± 0.110 إلى 2.208 ± ٪0.204 على التوالي لكل من الذكور والإناث. خلال فترة التسمين زادت نسبة الرماد في الذكور والإناث. بالإضافة إلى ذلك ، أظهرت الدراسة أن متوسط محتوى الألياف الخام ارتفع من 1.162 ± 0.089 إلى 1.613 ± ٪0.580 و 1.556 ± 0.367 إلى 1.884 ± ٪0.020 على التوالي بين الذكور والإناث. وعلاوة على ذلك ازداد محتوى الاستخلاص الخالي من النيتروجين من 0.838 ± 0.064 إلى 0.982 ± ٪0.238 لدى الذكور ومن 1.251 ± 0.421 إلى 1.682 ± ٪0.640 لدى الإناث. لوحظ أن جميع التركيبات الغذائية تغيرت بسبب التسمين.

Introduction

In coastal region the valuable fisheries resources, shrimp occupies a significant part in the country's exportable commodities. Considering the increasing demand of mud crab in National and international level, it has been creating popularity among the coastal communities (Azam et al. 1998). But it is quite necessary to mention that shrimp farm owners rarely dare to go for intensive culture of shrimp for doing so they should face disease problem and ultimately farmers get great economic loss (Zafar, 2005). Considering this fact and also with the increase demand of crab in the local and international markets, the crab has been getting emphasis as a potential aqua-species for the farmers. Khan (2005) has recorded 16 species of crabs from Bangladesh waters. Thirteen marine and three fresh water species of crabs were also reported by Siddiqui and Zafar (2002). Among the identified crab species it is reported that only *S. serrata* fetched a good market price and hence is fattened in Bangladesh. *S. serrata* is the most valuable species among the identified crabs of Bangladesh. *Scylla serrata* generally known as "green crab" or "mangrove crab" and locally known as "shila kankra", "habba kankra" or "kankra" (Saha and Ahmed, 1999). It is the most popular because of its size, meat quality, high price and export potential (Raj, 1991). It has proximate value of 11% crude protein, 0.38% fat, 0.71% carbohydrate, 85.78% moisture and 1.54% ash (Pervin, 1991). It is super dietary item for human and has an equal taste as the shrimp (Zafar and Siddiqui, 2000 and Siddiqui, 2001). In 2010-11 fiscal years Bangladesh earned 3760 million BDT through exporting of 348 MT crab in live condition whose price value was about 10 million BDT more than the recent past years (DoF, 2012).

The *Scylla serrata* is a euryhaline bottom feeder invertebrate belongs to the family Portunidae, common in estuaries and mangrove swamps throughout the Indo-Pacific region. It is widely distributed in the Bangladesh coastal water (Zafar and Siddique, 2000). Though this crab seems to prefer mangrove swamps, they exist in large numbers in the shrimp ponds and in the burrows of the peripheral dikes (Azam et al. 1998). Actual culture technique of mud crab is not yet developed in our country due to the seed scarcity. Farmers are still dependent on natural seeds.

People of the coastal region of Bangladesh follow traditional fattening process to fatten crab in small ponds (Chong, 1993; Christopher, 1992). These ponds are fenced by bamboo sticks to prevent escaping the crab. Fattening usually requires 12-15 days to complete. Within this time, premature crabs are well fed to develop their gonad and muscle fully. Local people usually collects crab from wild source such as mangrove swamps, shrimp gher, river etc., for fattening. Though mud crab fattening is highly profitable, insufficient supply of wild caught post moult crab is the major constrains of this industry. The physico-chemical parameters of Bangladesh coastal water is directly related to the climatic condition i.e., monsoon. These parameters are the primary concerned affecting the biological growth and mortality of *Scylla serrata* (Obayed, 1998). Therefore, the investigation was undertaken to enhance crab fattening in pen system of Bangladesh as well as to assess the mud crab fattening and proximate composition changes of mud crab due to fattening.

MATERIALS AND METHODS

Study Area & Duration:

The study area was at Badarkhali of Chakaria Upazila in the vicinity of Mathamuhuri River which lies between 21^{0}40$^/$57$^{//}$ N and 91^{0}58$^/$13$^{//}$ E (Fig.1).

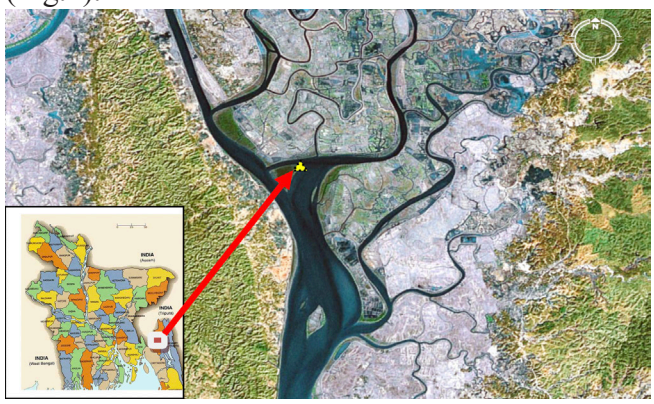

Fig. 1 Map of the selected study area ( ) and the site ( )

The study was carried out during December, 2011 to January, 2012. The fattening period of crab was 12 days.

Pen Construction and Setup

The culture areas were of 400 m^2 (20m x 20m) for pen-1 and pen-2; in case of pen-3 600 m^2 (30m x 20m). It was surrounded by (2 m height and 85 m long) pens made bamboo splits. The pen (locally called Bara) was dug 0.5 m into the mud and attached to the bamboo, mangrove and wooden poles to the structures to withstand against tidal flush. The supporting bamboo poles were interspersed 1.5 m apart. Two nylon nets were attached with the lower and upper part of the pen to prevent high water due to tidal action to control crab escaping from the pond and also to prevent birds entering the culture area. In the culture area 4.5 m length and 0.91 m width enclosure was dug for providing the crabs a survival place during low tide condition.

Stocking of Crabs

In Bengladesh, there is no hatchery of *Scylla serrata.* Most of the post moult 'water' crabs for fattening were collected from the local traders who collect from shrimp farms, mangrove swamp, river etc. Before releasing of water crabs in ponds they were acclimatized with pond water for about 30-40 minutes. Stocking rate was applied 14, 13 and 12 crabs. /2m^2 in respect of pen 1, pen 2 and pen 3. The weight of the post moult 'water' crab was 100-115 g (female) and 160-180 g (male).

Feeds and Feeding

Different types of trash fish and Anguilla species (eel fish) were used as a feed. The feeding time was at 8.0 am and in the late evening at 5.0 pm. The feed was given through broadcasting method as 5% of the total body weight twice a day.

Water Quality Parameter and Crab Sampling

Water quality parameters such as temperature (^oC), pH, salinity (‰) and dissolved oxygen (mg/l) were recorded at eel fish three days interval. Average growth rate, specific growth rate (SGR) and also feed conversion ratio (FCR) were determined by using following formulas:

$$\text{Average growth/day} = \frac{\textit{Final average weight - Intial average weight}}{\textit{Cuture period}}$$

SGR (% day) = [lnW2- ln W1]/ Duration of fattening (days)

[Here, W2= Mean final weight (g), W1 = Mean initial weight (g)]

Feed conversion ratio (FCR) = Weight of feed given/ Live weight gain

Estimation of Survival (%) and Production

The survival and production were estimated by the following formula:

Survival rate (%) = [Number of mud crab harvested/ No. of mud crab stocked] x 100

Production (kg) = Number of mud crab harvested × mean final weight (kg)

Harvest

In the pen system first crabs were fattened for 12 days and then they were harvested by net.

Proximate Composition

The method of AOAC (Association of Official Analytical Chemists) (AOAC, 1995) was followed for estimation of proximate composition (moisture, crude protein, crude lipid, ash, crude fibre and nitrogen free extract (NFE) of crab.

Data Analysis

The data (mean ± SD) obtained from this experiment was analyzed with the help of MS EXCEL 2007 and SPSS.

RESULTS

Water Quality Parameters

Water quality parameters recorded during the period are shown in Table. 1 and it did not very significantly within pens. During the study period water temperature fluctuated between 21^oC and 27^oC while the highest temperature was recorded on January 09, 2012 and the

lowest temperature was recorded on the December 26, 2011. The mean temperature of water was found to be 24.5±1.67^{O}C during the study period. The mean value of salinity of the studied period was 16.75±2.25‰. The pH values of the studied pens varied from 7.5 to 8. The highest pH value was recorded on January 1, 2012 and the lowest value was recorded on December 20, 2012. The mean value of pH was 7.94±0.34. Dissolved oxygen content in different pen varied from 4.1ml/L to 6.1ml/L. The highest value was recorded on January 11, 2012 and the lowest value was recorded on December 24, 2011. The mean value of DO was recorded 5.02±0.68 ml/L.

Table. 1 Water quality parameters of the crab fattening pens.

Days	Pen	Water temperature (^{0}C)	Salinity (‰)	pH	DO (ml/L)
20.12.2011 to 01.01.2012	Pen-1	21 – 26 (23.80±1.92)*	13 – 17 (15.30±1.72)	7.5 – 8.5 (7.78±0.29)	4.1 – 4.7 (4.34±0.25)
26.12.2011 to 06.01.2012	Pen-2	21 – 26 (24.3±1.98)v	14.5 - 18 (15.6±1.38)	7.6 – 8.5 (8.1±0.27)	4.1 – 5.2 (4.72±0.45)
04.01.2012 to 15.01.2012	Pen-3	24 – 27 (25.2±1.15)	15.5 - 20 (18.2±1.68)	7.5 – 8.5 (8.1±0.31)	4.1 – 5.5 (5.29±017)

* The figure in the parenthesis indicates average value with standard deviation.

Survival Rate

The average survival of the crabs was 64.567%, 65.892% and 67.107% for the pen-1, pen-2 and pen-3 respectively (Fig. 2). Whereas the mean values of the survival rate for male and female crabs were 64.722±1.204 and 65.889±0.701% respectively for the crabs of whole three pens (Fig. 3).

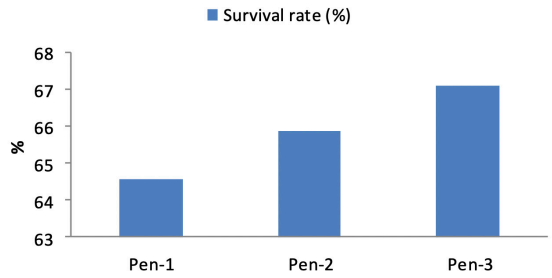

Fig. 2 Variation of survival rate (%) of crab *(S. serrata)* among different pens.

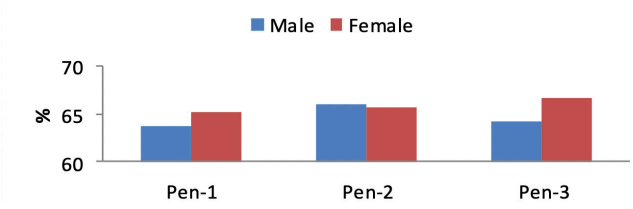

Fig. 3 Variation of survival rate (%) between male and female.

Growth Rate

Average growth rate/day of *S. serrata* was recorded in the pens was 1.440, 1.410 and 2.032 g for the pen-1, pen-2 and pen-3 respectively (Fig. 4). Again average growth rate (g/day) of male (1.777±0.276 g) was significantly higher than female (1.478±0.426 g) (Fig. 5).

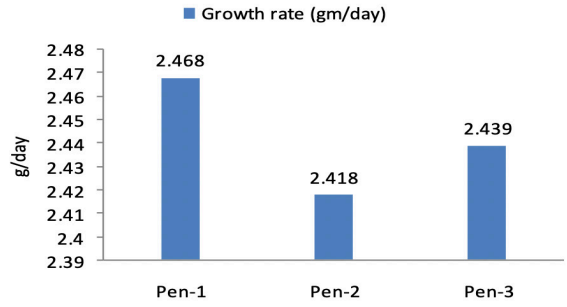

Fig. 4 Variation of growth rate (g/day) among different pens.

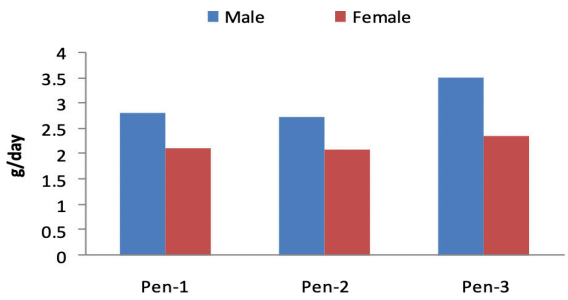

Fig. 5 Variation of growth rate (g/day) between male and female.

Specific Growth Rate (%)

The average percentages of specific growth rate (% SGR) of *Scylla serrata* were 0.986, 0.956 and 1.390% for the pen-1, pen-2 and pen-3 respectively (Fig. 6). Specific growth rate is more or less similar within pens but specific growth rate of male (1.245 ± 0.334%) is significantly higher than female (0.976 ± 0.152%) (Fig. 7)

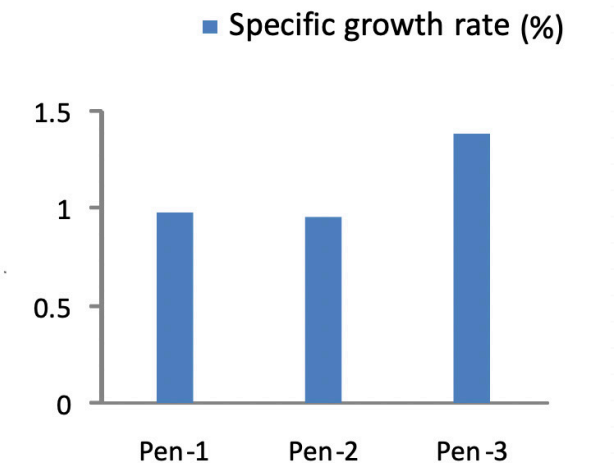

Fig. 6 Variation of specific growth rate (%) among different pens.

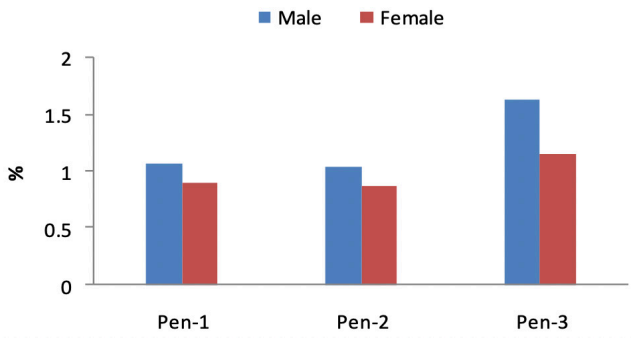

Fig. 7 Variation of specific growth rate (%) among male and female.

Feed Conversion Ratio (FCR)

In the study area the FCR of the pens were obtained 5.720, 5.958 and 5.822 for the pen-1, pen-2 and pen-3 respectively. The mean value of the FCR was 5.833 0.119 (Fig. 8)

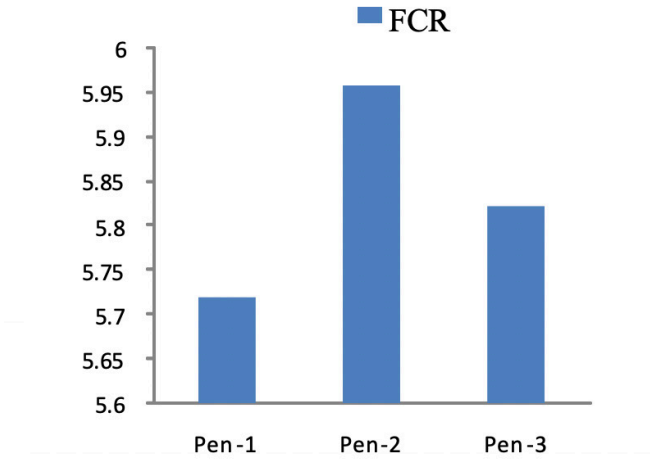

Fig. 8 Variation of Feed conversion ratio (FCR) among different pens..

Production rate (kg/m^2)

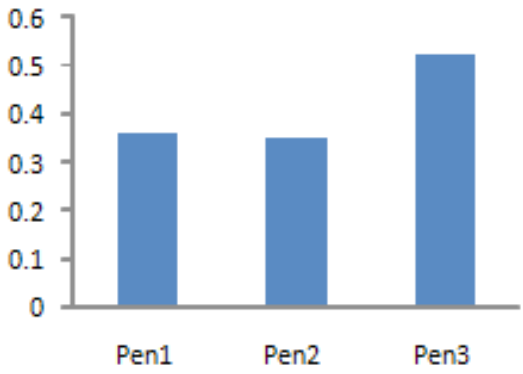

Fig. 9 Variation of production rate (kg/m^2) among different pens.

Statistical Analysis

The production rate was significantly ($p<0.05$) correlated with survival rate (Fig. 10). But the FCR was not significantly ($p>0.05$) correlated with survival rate (Fig. 11).

Table 2. Correlation co-efficient (r) between survival rate of *S. serrata* and production rate (kg/decimal).

Survival rate (%) (x)	Production rate (kg/dec.) (y)	Correlation co-efficient 'r'	Cal. Value 't'
64.567	14.463	0.826	1.468
65.892	14.087		
67.107	20.847		

• Positively correlated & 5% level of significance.

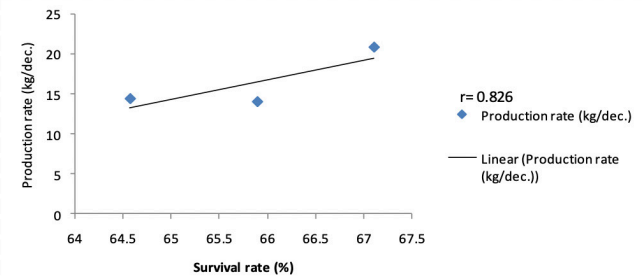

Fig. 10 Relationship between survival rate and production rate (kg/decimal)

Table 3 Correlation co-efficient (r) between survival rate of *S. serrata* and FCR.

Survival rate (%) (x)	Production rate (kg/dec.) (y)	Correlation co-efficient 'r'	Cal. Value 't'
64.567	5.720	0.450	0.503
65.892	5.958		
67.107	5.822		

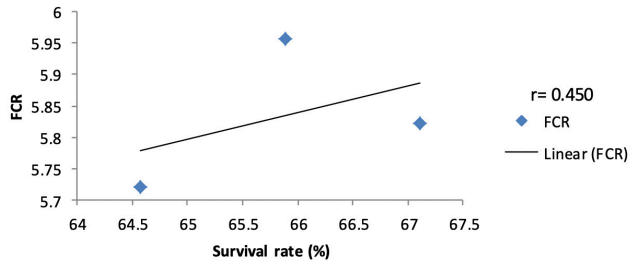

Fig. 11 Relationship between survival rate (%) and FCR

Proximate Composition of Crabs

The average weight of crab before fattening was 171.56±1.81 g with 91 mm carapace width (male) and 109.73±0.93 g width 77 mm carapace width. The average weight of crab after fattening was 192.88±1.91 g (male) and 127.46±0.87 g (female).

Proximate Composition of Mud Crab on Wet Weight Basis

The proximate compositions of the crabs in wet weight basis are shown in the table 4. The proximate composition of male post moult crabs i.e. before fattening found in the experiments were moisture 77.747±0.705%, crude protein 10.044±0.708, crude lipid 0.420±0.110, ash 9.789±0.702, crude fibre 1.162±0.089 and NFE 0.838±0.064% (Table 4). Again after fattening the proximate composition of the studied male crabs were moisture 75.551±1.537, crude protein 9.887±0.265, crude lipid 1.113±0.102, ash 10.407±0.198, crude fibre 1.613±0.580 and NFE 0.982±0.238% (Table 4). On the other hand proximate composition of female post moult crabs i.e. before fattening found in the experiments were moisture 75.030±0.370, crude protein 11.365±1.075, crude lipid 1.093±0.110, ash 9.618±1.050, crude fibre 1.556±0.367 and NFE 1.251±0.421% (Table 4) After fattening the proximate composition of the studied female crabs were moisture 74.332±0.202, crude protein 11.775±0.099, crude lipid 2.208±0.204, ash 10.407±0.198, crude fibre 8.120±0.561 and NFE 1.682±0.640% (Table 4).

Table 4. Proximate Composition of crab *(S.serrata)* with shell according to wet weight basis

Proximate composition	Male		Female	
	Before fattening (Mean ± SD)	After fattening (Mean ± SD)	Before fattening (Mean ± SD)	After fattening (Mean ± SD)
Moisture (%)	77.747±0.705	75.551±1.537	75.030±0.370	74.332±0.202
Crude protein (%)	10.044±0.708	9.887±0.265	11.365±1.075	11.775±0.099
Crude lipid (%)	0.420±0.110	1.113±0.102	1.093±0.110	2.208±0.204
Ash (%)	9.789±0.702	10.407±0.198	9.618±1.050	8.120±0.561
Crude fibre (٪)	1.162±0.089	1.613±0.580	1.556±0.367	1.884±0.020
NFE (٪)	0.838±0.064	0.982±0.238	1.251±0.421	1.682±0.640

*The table shows average value with standard deviation

Proximate Composition of Mud Crab on Dry Weight Basis

The proximate composition of male post moult crabs i.e. before fattening found in the experiments were crude protein 43.628±1.492, crude lipid 1.890±0.242, ash 44.287±0.825, crude fibre 7.698±0.504 and NFE 2.577±0.816% (Table 5.). After fattening the proximate composition of male crabs were crude protein 40.760±0.753, lipid 4.455±0.20, ash 42.616±0.098, crude fibre 7.868±0.258 and NFE 4.334±1.021% (Table 5). And the proximate composition of female post moult crabs i.e. before fattening found in the experiments were crude protein 47.713±1.278, crude lipid 4.389±0.201, ash 32.563±1.098, crude fibre 7.594±0.323 and NFE 7.739±1.167% (Table 5). After fattening the proximate composition of the female crabs were crude protein 45.860±0.384, crude lipid 8.605±0.172, ash 31.567±1.263, crude fibre 7.513±0.193 and NFE 6.454±0.2407% (Table 5).

Table 5. Proximate Composition of crab *(Scylla serrata)* with shell according to dry matter basis

Nutritional composition	Male		Female	
	Before fattening (Mean ± SD)	After fattening (Mean ± SD)	Before fattening (Mean ± SD)	After fattening (Mean ± SD)
Crude protein (%)	43.628±1.492	40.760±0.753	47.713±1.278	45.860±0.384
Crude lipid (%)	1.890±0.242	4.455±0.20	4.389±0.201	8.605±0.172
Ash (%)	44.287±0.825	42.616±0.098	32.563±1.098	31.567±1.263
Crude fibre (٪)	7.698±0.504	7.868±0.258	7.594±0.323	7.513±0.193
NFE (٪)	2.577±0.816	4.334±1.021	7.739±1.167	6.454±0.2407

DISCUSSION

Water quality parameters of *S. serrata* fattening pens were found within the acceptable ranges. In fattening period, the water temperatures ranged from 23 to 29 ^{0}C with the mean temperature of 23.80±1.92 ^{0}C. Zafar (2004) found the similar result of temperature ranges from 24.4 to 30.4 ^{0}C in Chakaria Sundarban area. Begum et al. (2009) found the similar finding of temperature variation in crab fattening pens in Khulna region of 26 – 31^{0}C. The salinity of was recorded between 13 and 20‰ and suitable for crab fattening. Begum et al. (2009) also found the similar result of salinity ranged between 10 ppt and 18 ppt in crab fattening pens of Khulna region. The mean pH value of the pens was recorded from 7.5 to 8. Zafar (2004) found the water pH ranges from 6.99 to 8.2 in crab fattening pond at Chakaria Sundarban areas. Dissolved oxygen content in different pen was recorded 5.02±0.68 ml/L which ranged from 4.1ml/L to 6.1ml/L. The similar concentrations of DO were observed by Begum et al. (2009), Zafar (2003).

Survival rates obtained in the ponds were 64.567, 65.892 and 67.107% for the pen-1, pen-2 and pen-3 respectively. Survival rate was increased with decreasing stocking density. Kamal (2002) found the survival rate of mud crab with stocking density of 1, 2 and 4 crab m 2 were 91, 64 and 42% respectively. Average growth rate/day of *Scylla serrata* was recorded in the pens was 1.440, 1.410 and 2.032 g for the pen-1, pen-2 and pen-3 respectively. Again average growth rate (g/day) of male (1.777±0.276 g) was significantly higher than female (1.478±0.426 g). This result is has similarity with the findings of Zafar (2003) and Obayed (1998) who recorded 1.16±0.2 g /crab/ day and 1.89 to 1.96 g/day. FCR of the pens were obtained 5.720, 5.958 and 5.822 for the pen-1, pen-2 and pen-3 respectively with a mean value of 5.833 0.119. These results were unsatisfactory when compared with Kamal (2002) who reported that the FCR was 2.2 to 4.8 where crabs fattened with tilapia feeds. The high FCR value may be due to use of low quality trash fish as feeds. The average specific growth rates (% SGR) of Scylla Serrata were 0.986, 0.956 and 1.390 % for the pen-1, pen-2 and pen-3 respectively. Specific growth rate of male (1.245 ± 0.334%) was significantly higher than female (0.976 ± 0.152%). Mwaluma (2002) reported that the SGR was 1.47-4.2% per day. These results showed resemblance with the present result. The productions of the crabs were 144.62 kg, 140.82 kg and 312.692 kg whereas the production rate of the crabs were 0.362 kg/m^2, 0.352 kg/m^2 and 0.521 kg/m^{2}for the pen-1, pen-2 and pen-3 respectively. The present value of production rate is higher than 0.325 kg/m^2 reported by Kamal (2002) where the stocking density was 4crabs/m^2. Begum et al. (2009) also found the similar result of production rate 0.37±0.01 kg/ m^2 in the earthen encircled pond. This production rate may be considered good for traditional crab fattening.

The moisture content of mud crab increased from 77.747±0.705% to 75.551±1.537% in male due to fattening. In female crab it decreased from 75.030±0.370% to 74.332±0.202%. Higher moisture content was found in male crab *(S. serrata)*. The findings of moisture contents is comparable to the findings of Zafar (2004) who found the average yearly value of moisture 79.53±3.42% in male and 77.29±4.93% in female. Due to fattening the mean crude protein content of the male mud crab *(S. serrata)* decreased from 10.044±0.708 to 9.887±0.265% on wet weight basis of whole crab. Whereas for female mud crabs mean crude protein content was increased from 11.365±1.075 to 11.775±0.099%. Analysis showed that the mean crude protein content was higher in female than male. Pervin (1991) found the similar result of 11% protein on moisture basis. The mean crude lipid content of mud crab increased from 0.420±.110 to 1.113±0.102% in male and from 1.093±0.110 to 2.208±0.204% in female on wet weight basis. Sundarrao et al. (2004) found the protein content of mud crab was 8.36% on wet basis. Higher crude lipid content was found in female mud crab than male. Zafar (2004) found the yearly mean value of fat 0.51±0.12% in male and 0.62±0.13% in female. The present findings of lipid content were

harmonious with the result of Sundarrao et al. (2004). The mean ash content also increased due to fattening from 9.789±0.702 to 10.407±0.198% in male and from 9.618±1.050 to 8.120±0.56% in female. The present findings were not similar with the result of Zafar (2004) who found the average ash content was 1.73±0.41% for male and 2.05±0.25% for female. The present findings of ash contents were satisfied with the result of Emmanuel et al. (2010) whofound the ash contents 14.9% in male and 7.4% in female. The mean crude fibre content of the crab was 1.162±0.089 to 1.613±0.580% in male and 1.556±0.367 to 1.884±0.020% in female. The crude fibre contents were increased during fattening for both male and female. Nitrogen Free Extract (NFE) content of male crab increased from 0.838±0.064 to 0.982±0.238% due to fattening. It also increased in female from 1.251±0.421 to 1.682±0.640%. Mean value of carbohydrate content was higher in female than male. Zafar (2004) found similar result of carbohydrate content 0.31-0.92% in male and 0.29 -1.29% in female. Khan (1992) reported 0.13% carbohydrate in male and 0.86% carbohydrate in female.

CONCLUSION

It may be concluded that fattening for 12 days undersized and lean marketable sized mud crabs is economically feasible. For the increase of survival rate and production in traditional mud crab fattening in pen system it is suggested that farmers should maintain minimum stocking density with nutritionally balanced diet. At present, *S. serrata* fattening in Bangladesh is still dependent upon wild juveniles. Hence, any commercial development in this direction needs to be considered as over exploitation of mature females and may aggravate the shortage of seeds supplies from the natural habitat. So, over-exploitation should be minimized by establishing crab hatchery in south-eastern part of Bangladesh.

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