World Journal of Fish and Marine Sciences 8 (1): 54-63, 2016
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2016.8.1.101192

Effects of Different Feeding Trial in the Proximate Composition of Shoal Fish (*Channa striatus*) Cultured in Glass Aquaria

[1]Abu Hena Muhammad Yousuf, [1]Md. Solaiman Hossain and [2]M. Belal Hossain

[1]Department of Oceanography, University of Dhaka, Dhaka-1000, Bangladesh
[2]Department of Fisheries and Marine Science, Noakhali Science and Technology University, Noakhali-3814

Abstract: Fish growth and feed utilization experiment of the juvenile Shoal fish have been carried out while rearing the fish in three glass aquaria in lab condition for a period of 35 days. Locally available raw materials have been used as feeding material. Known amount of fish feed was supplied in the aquaria according to the feeding interest and existing appetite of the experimental fish. A biometric measurements have been taken and analysis for proximate composition of the fish feed and the experimental fish has been carried out. Nutrient values of the fish have been found to increase from its initial values of protein 16.05%, fat 0.33%, ash content 1.18% to protein 20.39%, fat 0.62%, ash content 6.25% for feed A; to protein 18.2%, fat 0.4%, ash content 1.2% for feed B; to protein 23.34%, fat 1.3%, ash content 9.48% for feed C at the end of the study period. Mixed feed diets have been found to contain 29.93% protein, 3.96% fat and 5.01% ash with 59.97% moisture content. Results of the growth and feed utilization experiment of the juvenile shoal fish revealed that the fish is a good source of protein and feed utilization rate is satisfactory. The growth rate measuring parameters such as condition factor, ADG, SGR, muscle ratio, the survival rate and the feed utilization parameters such as FCR, PER, feed efficiency have been found to be the most efficient in case of feed C i.e. mixed fish diet. Length- Weight relationship of the experimental fish has been calculated and regression lines of weight on length of each aquarium has been drawn individually and linear relationship has been obtained for each case. The correlation coefficient (r) values between length and weight have been found to be 0.985, 0.977 & 0.971 at 0.01 confidence level in case of aquaria 1, 2 and 3 respectively.

Key words: Processed Feed · Proximate Composition · Length-Weight Relationship · Feed Test

INTRODUCTION

The growth of biomass of fish under intensive culture depends upon various factors notably on feeding regime. One problem facing fish culturist is the need to obtain a balance between a rapid fish growth and optimum use of the supplied feed. In fish farming nutrition is critical because feed represent 70-80 % of production cost [1]. Striped snakehead, *Channa striatus,* locally known as shol in Bangladesh belonging to the family of Channidae, is one of the favorite freshwater fishes in the Asia-Pacific countries [2]. It is commonly available in the rivers, lakes, swamps, marshes, *beels*, *haors* and ponds. The total production of snakehead fishes in Bangladesh is 1, 02,686 ton which is around 4.21% of the total fish production of the country [3]. It is a voracious carnivore feeding mainly on live animals ranging from invertebrates larvae and fry of other fishes, large fishes to even frogs. Under condition of food deprivation, snakeheads can also become cannibalistic [4] and it appears to be the most common problem in rearing the fry of snakeheads [5]. It can reach a size of 1 m [6] with highest weight recorded to be 3 kg [7]. It is widely consumed for its nutritional value and beneficial effect in wound healing [8, 9]. The snakehead *C. striatus* has for long been commercially cultured in many countries for its good taste, market value and medicinal qualities [10].

The sustainable culture operation of any fish species requires proper domestication, fry feeding and rearing and culture technique of the species concerned. Effects of feed application rates on growth, survival and feed conversion of juvenile snakehead murrel, *C. striatus* have been reported and it was recorded that growth, survival and feed conversion ratio of juvenile snakehead murrel

Corresponding Author: Abu Hena Muhammad Yousuf, Department of Oceanography, University of Dhaka, Dhaka-1000, Bangladesh.

(*C. striatus*) were evaluated when fed a dry formulated feed with 50% crude protein [11]. In *C. striatus* size and feed dependent cannibalism with juveniles were reported by Qin and Fast [12]. In view of above facts and figures, investigations have been carried out to determine the growth performance and feed utilization of Shoal fish (*C. striatus*) after feeding and rearing in glass aquarium of Fish Technology Laboratory of IFST, BCSIR, Dhaka. Because of its fast growth nature carnivorous habits the finding of the study is assumed to be helpful for its monoculture on commercial basis in Bangladesh.

MATERIALS AND METHODS

Experimental Design: For feeding trial of Shoal fish *(C. striatus)* three aquaria having length and width (47 inch× 18 inch) containing 35 liters water were cleaned and prepared with chemical treatment, dose: formalin (40%) at the rate of 15-25 mg/l; common salt at the rate of 10mg/l and savlon. After the completion of preparation of the aquaria in Fish Technology Lab, BCSIR, Dhaka, 30 juvenile Shoal fishes (*C. striatus)* with average length 16.85±0.5 cm and weight 30.05±0.2 g for aquarium 1; average length 16.79±0.61 cm and weight 29.56±0.33 g for aquarium 2; average length 17±1.14 cm and weight 30±8.47 g for aquarium 3 were collected from the local fish market. The fish were acclimatized in the aquaria for a few days so that the fish may adopt with the new ecological condition.

Feed A: Raw small shrimp & kachki (*Corica soborna*) fish for aquarium 1; Feed B: dry kachki (*C. soborna*) fish for aquarium 2 and Feed c: mixed fish diet (i.e. small raw shrimp: raw kachki (*C. soborna*) fish: dry kachki (*C. soborna*) fish: 1:1:1.5) for aquarium 3 were served separately to the fish for feeding trial. The feeding trials were carried out for 35 days with a view to assessing the growth rate and feed utilization. During the experimental period, known weights of mixed diet were taken and were given to the Shoal in the aquaria. The fish diets were given up to that amount that which were consumed by the fish. No fish diets were allowed to be wasted. The amount of fish feed were thus recorded on daily basis. The feeding interest of the experimental fish were observed every day and at the end of 7, 14, 21, 28 and 35days, the length and weight of the fish were recorded and the fish at the initial and end period of feeding trial were analyzed for proximate composition. The total weight and muscle weight of the fish were recorded in order to calculate the muscle ratio of the fish. The proximate composition of the ingredients of the fish diet was analyzed and the proximate composition of the mixed diet was also analyzed determined in the laboratory.

The methods used during the feeding trial have been mentioned below. The proximate compositions of the shoal fish were determined for knowing the condition of fish. Initial length & weight of fish were recorded and this would be continued with 7 days interval up to 5th week. Several parameters such as Condition factor or Ponderal index, Feed conversion ratio (FCR), Protein efficiency ratio (PER), Feed Efficiency, Muscle ratio (MR %), Estimation of survival rate, Specific growth rate (SGR %), Average daily gain (ADG) and Weight gain were also recorded for estimating the performance of fish diets.

Proximate Composition of Raw Fish: The fishes were taken out of the aquarium and de-headed. The fishes were then cut along the dorso-lateral side to separate muscle and these fillets were split into small pieces to produce a homogeneous product. Two samples (initial and final) were analyzed for the determination of the each nutrient content. The proximate composition on dry matter basis of raw fish, fish diets were determined as per methods of the Analysis Association of Official Analytical Chemists, international [13].

Estimation of Moisture: Moisture of fish is commonly determined by drying a sample at some elevated temperature and reporting the loss in weight in terms of moisture [14].

$$\% \text{ of moisture} = \frac{\text{Weight loss}}{\text{Orignal weight of the sample taken}} \times 100$$

Moisture factor = (100 – moisture) / 100

Estimation of Ash Content: Ash in fish and fish products is readily determined by incineration from either raw or dried sample at about 600-700°C for 5-8 hours, depending on the method used. The residue is weighed and reported as ash [14].

$$\%\, of\ ash = \frac{Weight\ of\ dry\ sample}{\text{Orignal weight of the sample taken}} \times 100$$

Estimation of Protein Content: The crude protein of the fish was determined by Micro- Kjeldhal method. The percentage of nitrogen I sample was calculated by the following formula

% of N_2 = (Titration reading-blank reading) X strength of Acid X100/5 X 100/ weight of the sample. For most routine purpose the % of protein in the sample is the calculated by multiplying the % of N_2 with an empirical factor 6.25 for the fish.

% of the protein=% of total N_2 X 6.25

Estimation of Lipid Content: The estimation of fat content of experimental raw fish, smoke cured fish samples had been accomplished by Bligh and Dryer method [15].

$$\%\,of\ fat = \frac{Weight\ of\ the\ residue}{Weight\ of\ the\ sample\ taken} \times 100$$

Fish Growth and Feed Utilization Parameters
Weight Gain:

Weight gain = Mean final fish weight–mean initial fish weight

Condition Factor: This is the factor through which condition of the fish is expressed in numerical terms i.e. degree of plumpness or fatness is usually estimated as the condition factor or ponderal index 'k'. Fulton's condition factor (K) for each individual was calculated according to Htun-Han [16] equation

$$K = \frac{W}{L_3} \times 100$$

Where,
W is the body weight (BW) and L, the total length (TL).

Average Daily Gain (ADG): Average daily gain was determined by the following formula:

$$ADG = \frac{Total\ final\ fish\ weight - Total\ initial\ fish\ weight}{Time(T2 - T1)}$$

Specific Growth Rate (SGR %): Specific growth rate (SGR) was calculated as the percentage increase in weight per animal per day.

Calculation:

$$SGR\% = \frac{LnWT - LnWT}{T - t} \times 100$$

Where, SGR% = percentage increase in body weight per fish per day

LnW_T= natural log of weight at time T
LnW_t= natural log of initial weight at time t

Estimation of Survival Rate: The survival rate of Shoal (*C. striatus*) fish for each treatment and replication were estimated on the basis of number of fish harvested at the end of the 7, 14, 21, 28 and 35 days of feeding trial of the experimental fish at the aquarium. The survival rate was calculate by counting the actual number of fish survived, divide by the initial number stocked and multiplying by 100 and thus,

$$Survival\ rate(\%) = \frac{No.of\ actual\ fish\ survived}{No.of\ actual\ fish\ stocked} \times 100$$

Muscle Ratio (MR %): Muscle Ratio (MR) was determined by the following formula:

$$Muscle\ ratio\ (MR\%) = \frac{Muscle weight}{Total\ body\ weight} \times 100$$

Feed Efficiency: Feed efficiency was determined by the following formula:

$$Feed\ efficiency = \frac{Weight\ gained\ in\ wet\ weight}{Feed\ intake\ in\ dry\ weight} \times 100$$

Protein Efficiency Ratio (PER): Protein efficiency ratio (PER) was determined by the following formula:

$$PER = \frac{Total\ weight\ gained}{Protein\ fed} \times 100$$

Feed Conversion Ratio (FCR): Feed conversion ratio (FCR) is calculated from the number of kilograms of feed that are used to produce 1 kg of whole fish. Feed conversion ratio (FCR) was determined by the following formula:

$$FCR = \frac{Feed\ consumed\ by\ the\ fish\ (g)\ (dry\ weight\ basis)}{Liveweight\ of\ the\ fish} \times 100$$

RESULTS AND DISCUSSION

Proximate Composition of the Shoal Fish (*C. striatus*): The results of the proximate composition of the Shoal fish (*C. striatus*) at the initial and final day of the experimental period have been represented in Table 1. It is evident from the results that the nutrient contents of fish have increased from its initial value.

Table 1: Proximate composition of Shoal fish (*C. striatus*)

		Final days (35)		
Parameters	Initial day (0)	Feed A	Feed B	Feed C
Moisture (%)	81.35±0.14	77.27±0.24	78±0.21	57.99±0.05
Protein (%)	16.05±0.17	20.39±1.96	18.2±1.2	23.34±0.25
Fat (%)	0.33±0.01	0.62±0.01	0.4±0.04	1.30±0.02
Ash (%)	1.18±0.05	6.25±0.55	1.2±0.03	9.48±0.04

Table 2: A comparison of proximate composition of *C. striatus* with that of other fishes

Species	Protein	Fat	Ash	Moisture	Source
Parachanna obscura	21.5	17.30	7.76	51.1	[20]
Synodontis clarias	22.0	3.40	na	na	[21]
Salmo gairdneri	19.0	2.0	1.10	78	[22]
C. striatus	23.0	11.90	1.80	na	[23]
C. striatus	20.64	0.77	5.64	71.09	This study

na: Not Available

Table 3 Proximate composition of the ingredient of the three fish diets.\

	Feed Types		
	Feed A	Feed B	Feed C
Parameters	Raw small shrimp + Raw kachki fish	Dry kachki fish	Mixed fish diet
Moisture (%)	81.82±0.21	16.26±3.42	59.97±27.07
Protein (%)	12.58±0.55	64.64±9.68	29.93±39.78
Fat (%)	1.67±0.02	8.55±0.09	3.96±5.32
Ash (%)	2.23±0.04	10.55±0.12	5.01±6.42

Our findings agreed with the findings of Saha *et al.* [17], who reported that immature fish contain more moisture but less protein which is observed in case of the juvenile Shoal fish at the initial day of the experiment. Our findings have got similarities with the findings of Jacquet [18], Jafri [19]; who observed that the chemical composition of the fish is expected to vary largely from one species to another within the same species from one individual and another and even within the same specimen. The proximate composition of *C. striatus* and other fishes has been represented in Table 2 which were studied by some researchers.

The Proximate Composition of the Ingredient of the Fish Diet: The proximate composition of the ingredient of the fish diet and mixed fish diet has been represented in Table 3.

The dry fish have been mixed with a view to increasing the protein contentof the mixed fish diet. Watanebe *et al.* [24] worked with red tilapia having 8.7g weight for a period of 84 days. Fish were fed on commercial fish diet containing 28-32% protein. They observed that the fish fed with 28% protein gave the higher mean weight (166.4g) under all densities.

Growth Parameters of the Juvenile Shoal Fish (*C. striatus*): The results of the growth parameters of the juvenile Shoal fish at different time interval during the feeding trial in laboratory aquariums have been represented in figures 1, 2 and 3. Parameters indicating the growth rate of the experimental fish e.g., condition factor, Average daily gain (ADG), Specific growth rate (SGR), Survival rate and muscle ratio (MR), Feed conversion ratio (FCR), Protein Efficiency Ratio (PER), Feed Efficiency (FE%) have been estimated for individual aquarium to know feed efficiency.

Condition Factor (%): The values of condition factor have been found 0.66 to 0.75; 0.64 to 0.75 and 0.67 to 0.85 for feed A, B and C respectively at the interval of 7 to 35 days, of the feeding trial of the juvenile Shoal fish. The values of the condition have been found to increase with the progress of time of the feeding and rearing experiment. The condition factor was also observed in *C. striatus* and it was 0.74 which was very close to this study, implicating that the fishes were in good condition which indicates the suitability of these species for culture [25]. The condition factor (K) of a fish reveals that the recent physical, biological circumstances and fluctuates by interaction

among feeding conditions [26] and ultimately an indicator of the general fish condition. Besides, information on condition factor can be vital to system of culture management [27]. Beshra [28] observed the values of condition factor near about one.

Average Daily Gain (ADG): The average daily gain of experimental Shoal fish (*C. striatus*) have been observed higher in feed C than others and it was 0.7g calculated at different interval of time during the study period of the feeding trial experiment to assess its growth rate and feed utilization capacity. The average daily gain (ADG) was also reported of *Anabas testudineus* fish ranging from 0.10-0.12 g in weight [29]. The average daily gain (ADG) in case of the juvenile Shoal fish in our study is much higher and satisfactory in comparison with the findings' of Sangrattanakhul [29].

Specific Growth Rate (%): In figures 1, 2 and 3 for feed A, feed B and feed C respectively, the specific growth rates (SGR) of the juvenile Shoal fish (*C. striatus*) have been represented. That with the increase of age of the fish the value of SGR decreases which may ascertain the growth of the experimental fish. These findings resemble the Medwars [30] "the specific growth rate declines more and more slowly as the organism increase in age". Minot [31] was the first person to recognize that for most animals the specific growth rate is highest early in life and it typically decreases with increase of age, becoming zero in some animals. Mondal [32] observed the values of SGR % from 4.85-1.25 during 9 weeks experimental period in case of GIFT tilapia. Similarly, in our present study, it was observed that the line graph of SGR% value with the progress of experimental period was slightly downward. The SGR was also observed in *P. obscura* for different protein level feeding trial and ranged from 1.08 to 2.55% per day [33].

Muscle Ratio (MR): The values of muscle ratios have estimated that they were increasing with increasing the interval period but the value of MR is the best in case of feed C trial in shoal fish which is given in figure 3. The gradual increase of muscle ratio value is a clear indication of well growth rate pattern. Mustafa *et al*. [34] have worked in the field of growth performance and body composition of Red sea bream and observed values of muscle ratio (MR %) within the range of 35.2-37.40 to which our observed values of muscle ratio in case of feed C (25.84-40.35) have got close similarities.

Feed Conversion Ratio (FCR): In the figures 1, 2 and 3 the results of the FCR value, have been shown that feed A had sharp upward trend. Chakraborty *et al.* [35] have worked with the *Labeo rohita* to assess the feed utilization capacity and reported FCR value ranging from 1.30 to 1.99. Similar result was found in case of feed C (1.01 to 1.25). The FCR value considerably decreased as the dietary protein level increased in Nile tilapia fish and ranged from 3.27 to 3.39 [36].

Protein Efficiency Ratio (PER): According to Fig. 2, there is a sharp increasing trend in feed B. However, the values of PER in case of the juvenile Shoal fish during feeding trial with three feed containing different proximate composition and reared in the three aquariafor 35 days have been represented in fig.4. The overall results of PER shown in figs. 1,2 and 3 revealed a clear indication of increasing trends with the progress of rearing period of juvenile Shoal fish fed with formulated fish diet which is ranged from 0.35 to 2.56. The PER value was reported in *P. obscura* and ranged from 0.03 to 0.04 [33]. The observation made by Doolgindachabaporn [37] found that the value of PER ranges from 0.9 to 2.1. Mustafa *et al.* [34] in a study with formulated fish diet observed PER ranged from 1.31 to 1.60.

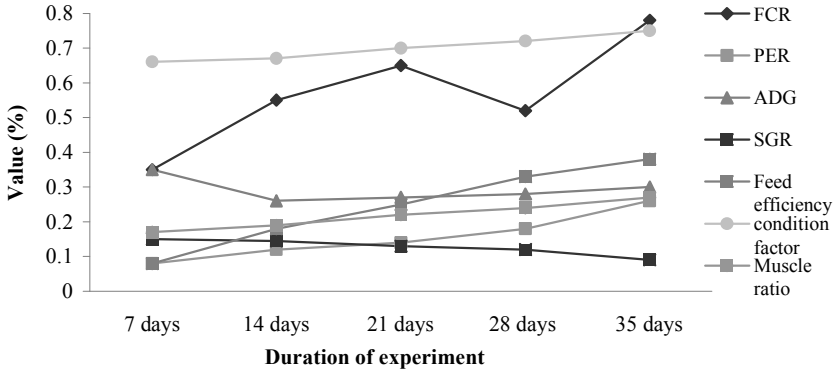

Fig. 1: Growth parameters for feed A after 35 days

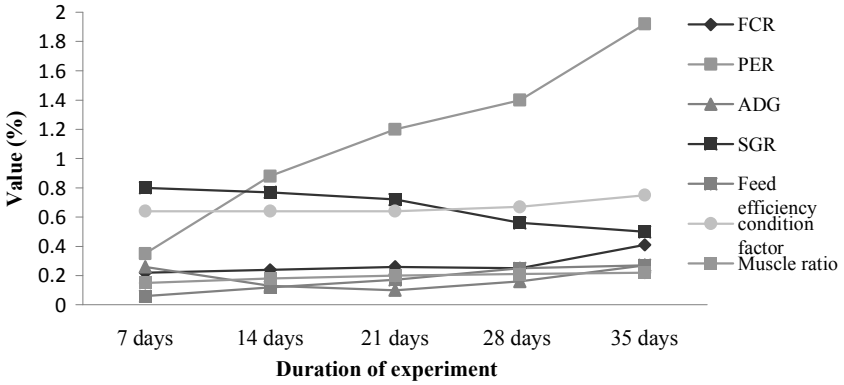

Fig. 2: Growth parameters for feed B after 35 days

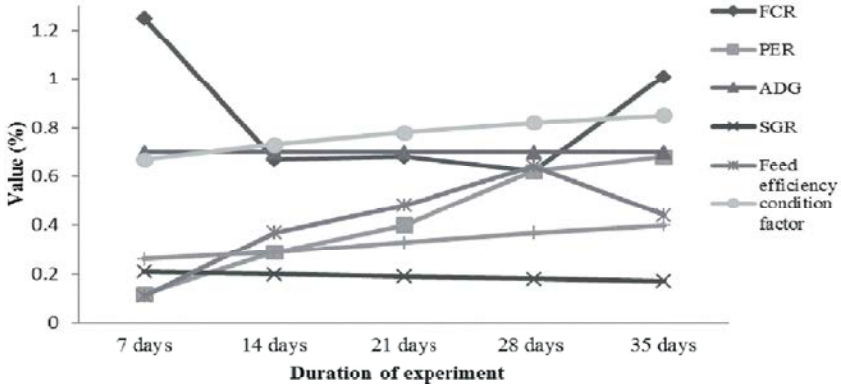

Fig. 3: Growth parameters for feed C after 35 days

Feed Efficiency (FE %): The feed efficiency values obtained in case of Shoal fish during feed utilization measurement trial have been depicted in figures 1, 2 and 3 for feed A, feed B and feed C respectively. Sahid [38] have got the values of feed efficiency between 40.7-42.3 in case of *Anabas testudineus* fish fed on fish feed maintaining protein level above 35%. They also observed that the fish feed containing protein less than 35% gave poor feed efficiency compare to the groups fed on 35% protein or above. Mustafa *et al*. [34] in his growth performance study of Red sea bream observed feed efficiency value ranged from 51.5- 62.3% fed on feed having protein level 38.5%- 39.3%. Some of the values of feed efficiency (FE) in our study have been found have similarities with the findings of Sahid [38] and Mustafa *et al.* [34] and some of the values are not similar.

Survival Rate (%): The survival rate was obtained 85 to 100% in case three kinds of feeding trial. The survival rate was also observed in *P. obscura* and found 100% [33].

Feed Test: The performances of three kinds of feed in each aquarium were recorded every other 7 days on the basis of length gained (%), weight gained (%), condition factor (%), average daily gain (%), specific growth rate (%), muscle ratio (%), feed efficiency (%), FCR (%), survival rate (%). Among them, the performances of feed C were outstanding which were given through bar diagram in the following figures 4, 5, 6, 7 and 8.

Length-Weight Relationship: The length-weight relationships of the juvenile Shoal fish have been determined to know the growth performance during feeding trial. The correlation coefficient of feed A, feed B and feed C value (r) has been calculated have been found to be 0.985, 0.977, 0.971 respectively. The values of 'r' of each and every feed have been found to have strong and highly significant relationship at 0.01 levels. The result of the present study have got similarities with the findings of Khan [39] and Uddin [40] who have got strong and highly significant relationship between length and weight in case of GIFT tilapia and *Oreochromis niloticus.*

Regreessioin Analysis: The regression lines of weight on length of the juvenile shoal fish (*Channa striatus*) during the feeding trial in each aquarium in laboratory condition

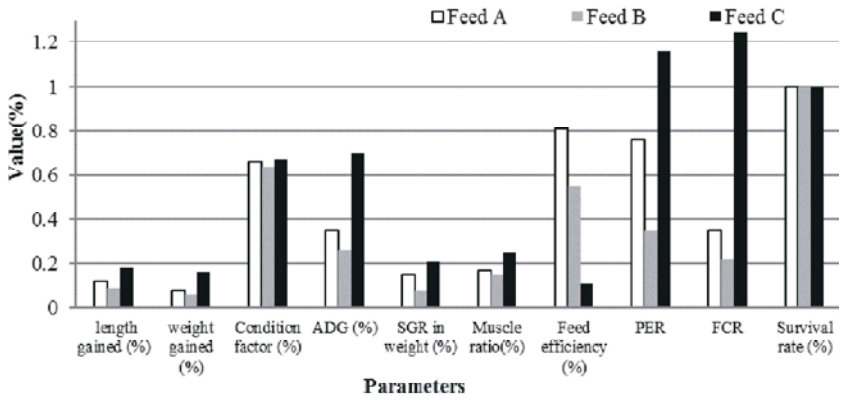

Fig. 4: Different growth parameters of shoal fry by feeding three kinds of feed after 7 days

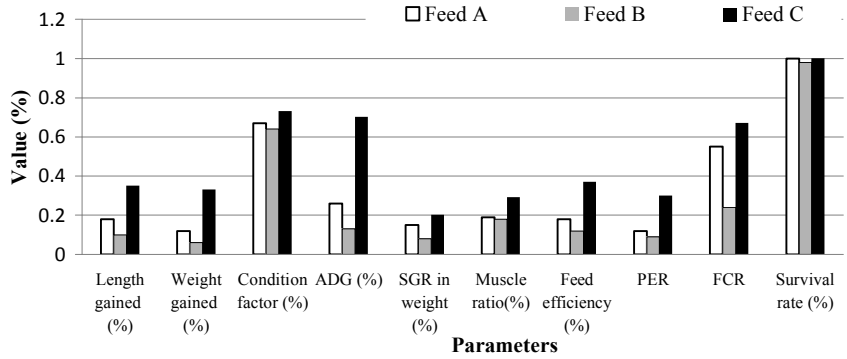

Fig. 5: Different growth parameters of shoal fry by feeding three kinds of feed after 14 days

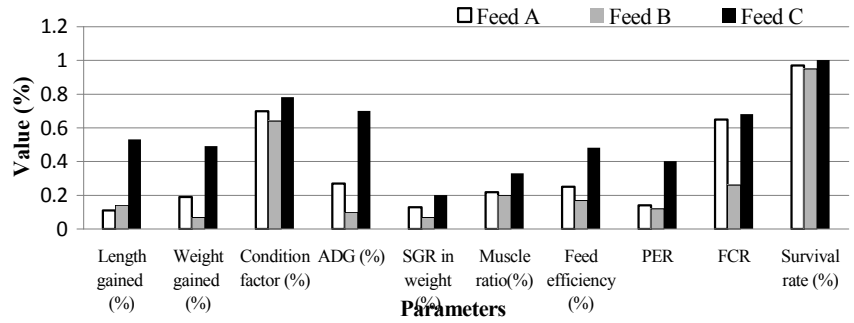

Fig. 6: Different growth parameters of shoal fry by feeding three kinds of feed after 21 days

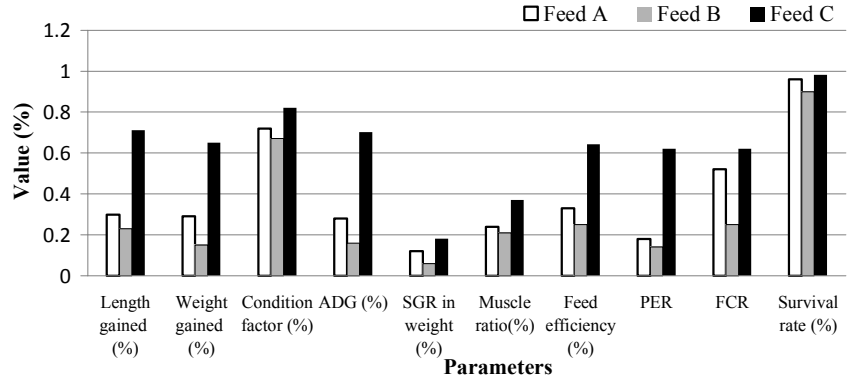

Fig. 7: Different growth parameters of shoal fry by feeding three kinds of feed after 28 days

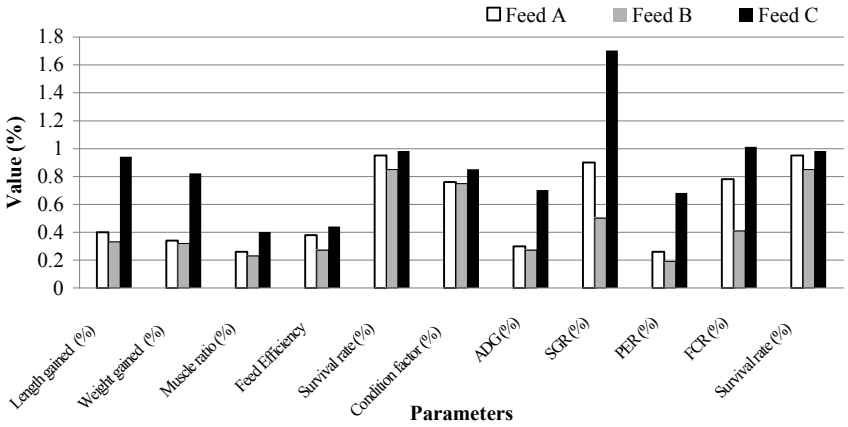

Fig. 8: Different growth parameters of shoal fry by feeding three kinds of feed after 35 days

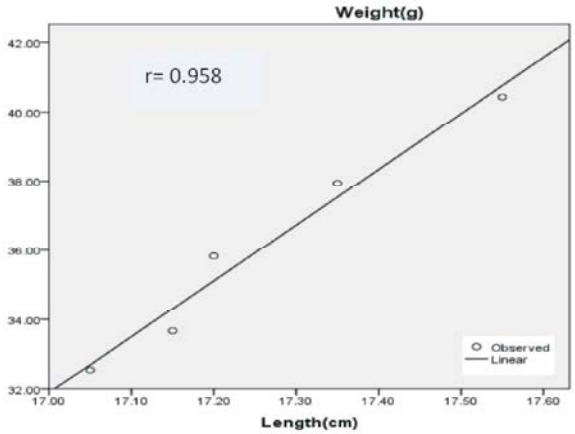

Fig. 9: Length-weight regression analysis of feed A after 35 days feeding trial on *C. striatus*

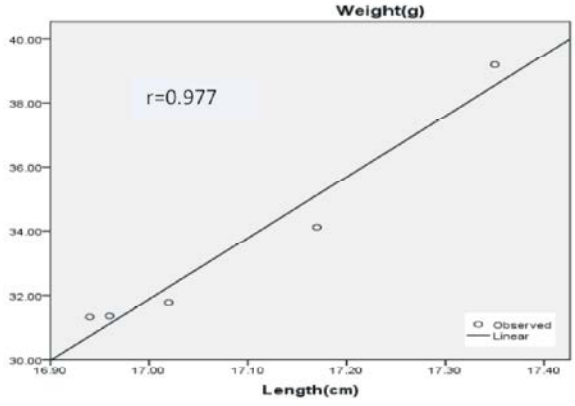

Fig. 10: Length-weight regression analysis of feed B after 35 days feeding trial on *C. striatus*

have been represented in figs. no. 9, 10 and 11. It is evident from the figures no. 9, 10, 11 that the weight on length regression line is a linear relationship in case of feed A, feed B and feed C. This kind of weight on length

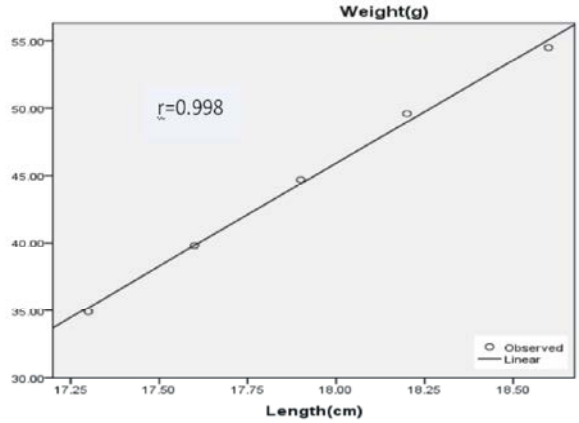

Fig. 11: Length-weight regression analysis of feed C after 35 days feeding trial on *C. striatus*

regression line having linear relationship have also been observed by Uddin [39] in case of *Oreochromis niloticus* and *P. gonionotus.* The co-efficient of determination (r^2) values explained the proper fit of the model for growth. In the present study, r^2 of C. *striatus* was higher than 0.95 in all the feeding trial, while it was higher in 0.99in case of feeding trial of feed C, indicating the good fitness. The value of r^2 was also reported in C. striatus and which was 0.98 [41] and very close to this study. The statistical analysis especially length-weight correlation, regression, were done by SPSS software version 20.0

CONCLUSION

To meet the protein demand, for the culture of *C. striatus,* best fish feed utilization is very essential. The present investigation reveals that the mixed fish diet (i.e. feed C) has the best growth performances of shoal fry among the three feeds.

ACKNOWLEDGEMENT

The authors express their profound gratitude to Fish Technology Research Lab, Institute of Food Science Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka for its generous support by providing the essential laboratory facilities. The anonymous reviewer is also thanked for his/her valuable comments which intensively develop manuscript.

REFERNCES

1. Craig, S. and L.A. Helfrish, 2002. Understanding Fish Nutrition, Feeds and Feeding. Department of Fisheries and Wild Life Sciences, Virginia Tech., pp: 420-456.
2. Gam, L.H., C.Y. Laow and S. Baie, 2005. Amino Acid Composition of Snakehead fish (*Channa striatus*) of various sizes obtained at different times of the year. Malaysian J. of Pharma. Sci., 3(2): 19-30.
3. FRSS (Fishery Resources Survey System), 2008. Fishery Statistical Yearbook of Bangladesh. Department of Fisheries, Dhaka. pp: 47.
4. Boonyaratpalin, M., E.W. McCoy and T. Chittapalapong,, 1985. Snakehead culture and its socio-economics in Thailand. Annual Report, Fisheries and Aquaculture Department, Thailand., pp: 27.
5. Ng, P.K.L. and K.K.P. Lim, 1990. Snakeheads (Pisces: Channidae): Natural history biology and economic importance. In: Chou, L.M. and Ng, K.L.P. (eds.), Essays in Zoology. Papers commemorating the 40th Anniversary of the Department of Zoology. National University of Singapore, Singapore. pp: 127-152.
6. Davdison, A., 1975. Fish and Fish Dishes of Laos. Imprimerie Nationale Vientiane. pp: 202.
7. IGFA, 2001. Database of IGFA angling records until 2001. IGFA, Fort Lauderdale, USA.
8. Wee, K.L., 1982. Snakeheads-their biology and culture. In: Muir, R. (ed.) Recent advances in aquaculture. Boulder, CO: Westview Press., pp: 181-213.
9. Mat Jais, A.M., R. McCullock and K. Croft, 1994. Fatty acid and amino acid composition in human as potential role in wound healing. Gen. Pharmacol., 25: 947-950.
10. Marimuthu, K., M.A. Haniffa, M. Muruganandam and A.J. Arockia Raj, 2001. Low cost murrel seed production technique for fish farmers, Naga, 24(1-2): 21-22.
11. Qin, J. and A.W. Fast, 1996b. Effects of feed application rates on growth, survival and feed conversion of juvenile snakehead *Channa striatus*. J. World Aquacult. Soc., 27(1): 52-56.
12. Qin, J. and A.W. Fast, 1996a. Size and feed dependent cannibalism with juvenile snakehead *Channa striatus*. Aquaculture, 114: 313-320.
13. A.O.A.C., 1990. (Association of Official Analytical Chemists). Official Methods of Analysis Association of Official Analytical Chemists. 15th edition. Ed. Herich, k. Published by the Inc. Suite.400; Arlington, Virginia, 2: 685-1298.
14. Azim, M.A., M.R. Islam, M.B. Hossain and M.H. Minar, 2012. Seasonal Variations in the Proximate Composition of *Gangetic Sillago*, *Sillaginopsis panijus* (Perciformes: Sillaginidae). Middle-East Journal of Scientific Research, 11(5): 559-562
15. Bligh, E.G. and W. Dyer, 1959. Total lipid extraction and purification. Can, J. Biochem. Physiol., 37: 99-110.
16. Htun-Han, M., 1978. The reproductive biology of the dab *Limanda limanada* (L.) in the North Sea: gonadosomatic index, hepatosomatic index and condition factor. Journal of Fish Biology, 13(1): 351-377.
17. Saha, M.R., M.F.A. Mollah and P.K. Roy, 1998. Growth and survival of *Clarius batrachus* (Lin.) larvae feed on formulated diets. Bangladesh J. Fish. Res., 2(2): 151-158.
18. Jacquot, R., 1961. Organic constituents of fish and other aquatic animals. Fish as food. Edited by Borgstrom. Acadenic press, N.Y. and London, 1: 145-209.
19. Jafri, AK., 1969. Seasonal changes in the biochemical composition of freshwater catfish (Wallagu attu Bloach). Hydrobiologia, 33: 497-506.
20. Ama-Abasi, D. and A. Ogar, 2013. Proximate Analysis of Snakehead Fish, *Parachanna obscura*, (Gunther 1861) of the Cross River, Nigeria. Journal of Fisheries and Aquatic Science, 8(1): 295-298
21. Baliu, J.K. Ogu and C. Onwuemme, 2007. Condition factor, fat and protein content of five fish species in Lekki. Lagoon, Nigeria Life Sci. J., 4: 54-57.
22. Kinsella, J.E., J.L. Shimp, J. Mai and J. Weihrauch, 1984. Sterol, phospholipid, mineral content and proximate composition of fillets of select freshwater fish species. J. Food Biochem., 1: 131-140
23. Zuraini, A., M.N. Somchit, M.H. Solihah, Y.M. Goh and A.K. Arifah, 2006. Fatty acid and amino acid composition of three local Malaysian *Channa* spp. Fish. Food Chem., 97: 674-678.

24. Watanabe, W.O., J.H. Clark, J.B. Dunham, R.J. Olla, W.B.L. 1990. Culture of Florida red tilapia in marine cages. The effect of stocking density and dietary protein on growth. Aquaculture, 90(2): 123-124.
25. Kumar, K., P.L. Lalrinsanga, Minaski Sahoo, U.L. Mohanty, Rajesh Kumar and A.K. Sahu, 2013. Length-weight Relationship and Condition Factor of *Anabas testudineus* and Channa Species under Different Culture Systems. World Journal of Fish and Marine Sciences, 5 (1): 74-78
26. Le Cren, E.D., 1951. The length-weight relationships and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal Animal Ecology, 20: 201-219.
27. Araneda, M., E.P. Pérez and E. Gasca-Leyva, 2008. White shrimp *Penaeus vannamei* culture in freshwater at three densities: Condition state based on length and weight. Aquaculture, 283: 13-18.
28. Beshra, S., 1997. Growth and bioenergetics of *Anabas testudineus* (Bloach). Published by Freshwater Biological Association of India, Dept. of Zoology, T.M. Bhagalpur University, Bhagalpur-812007, India.
29. Sangrattanakhul, C., 1989. Effects of pelletized diets containing various levels of protein on growth and survival of climbing perch, *Anabas testudineus*, (Bloach). M.Sc. Thesis. Kasetsart University. Bangkok. Thailand, pp: 74.
30. Medwars, P.B., 1945. Size, shape and age in "Essays on growth and form presented to D'Arcy Went Worth Thompson" Oxford University Press.
31. Minot, C.S., 1998. The problem of age, growth and death, Murvey, London.
32. Mondal, M.A.H., 1997. Studies on the production of fry and culture of genetically improved farmed tilapia (GIFT) in ponds and cages. Annual Report of Department of Aquaculture, Bangladesh Agriculture University, Mymensingh. pp: 83.
33. Kpogue, Diane N.S., Grace A. Ayanou, Ibrahim I. Toko, Guy A. Mensah and E.D. Fiogbe, 2013. Influence of dietary protein levels on growth, feed utilization and carcass composition of snakehead, *Parachanna obscura* (Günther, 1861) fingerlings. International Journal of Fisheries and Aquaculture, 5(5): 71-77.
34. Mustafa, G., M. Shigeru, W. Mastu, T. Takeida, T. Umin and H. Nakagawa, 1995. Effects of algae meal as feed additive on growth, feed efficiency and body composition in Red Sea Bream Fisheries Science, 611(1): 25-28.
35. Chakraborty, S.C., S.A. Chowdhury and S. Chakraborty, 1999. Asian fisheries science, Asian Fisheries Society, Manila, Philippines. 12: 297-308.
36. Daudpota, A.M., Pirzada J.A. Siddiqui, Ghulam Abbas, Naeem Tariq Narejo, Syed Sajjad A. Shah, Noor Khan and G. Dastagir, 2014. Effect of Dietary Protein Level on Growth Performance, Protein Utilization and Body Composition of Nile Tilapia Cultured in Low Salinity Water. International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS), 2(2): 135-147.
37. Doolgindachabaporn, S., 1994. Development of optimal rearing and culturing system for climbing perch (*Anabas testudineus* Bloach) Doctoral thesis, Univ. of Manitoba, Canada; pp: 189.
38. Sahid, 1998. Studies on protein requirements of some culturable freshwater fishes Tilapia mossambica, *Anabas testudineus* and *Clarius batrachus* in formulated diets. Annual Report of Department of Aquaculture, Bangladesh Agriculture University, Mymensingh, pp: 37.
39. Khan, M.S.H., 1996. Culture of Genetically Improved Farmed Tilapia (GIFT) in cages. M.S. Thesis. Dept. of Aquaculture and Management, BAU, Mymensingh. pp: 28-52.
40. Uddin, M.J., 1998. Effect of fish culture in rice fields on the yields of rice and nutrients availability in soil, straw and grain. Annual Report of Department of Fisheries Management, Bangladesh Agriculture University, Mymensingh, pp: 29-68.
41. Kumar, K., P.L. Lalrinsanga, M. Sahoo, U.L. Mohanty, R. Kumar and A.K. Sahu, 2013. Length-weight Relationship and Condition Factor of *Anabas testudineus* and Channa Species under Different Culture Systems. World Journal of Fish and Marine Sciences, 5(1): 74-78.