J Bangladesh Agril Univ 18(2): 516–523, 2020 https://doi.org/10.5455/JBAU.95923

ISSN 1810-3030 (Print) 2408-8684 (Online)

Journal of Bangladesh Agricultural University

Journal home page: http://baures.bau.edu.bd/jbau

Utilization of pangas (*Pangasianodon hypophthalamus*) processing waste in preparation of tilapia (*Oreochromis niloticus*) fish feed

Md. Ismail Hossain, Fatema Hoque Shikha✉, Md. Mahabubul Alam

Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFO

Article history:
Received: 30 March 2020
Accepted: 30 April 2020
Published: 30 June 2020

Keywords:
Pangas processing waste,
Supplementary feed,
Fish feed,
Weight gain,
Tilapia fish

Correspondence:
Fatema Hoque Shikha
✉: shikhafh@bau.edu.bd

ABSTRACT

The study was conducted for three months at the Faculty of Fisheries, Bangladesh Agricultural University to reveal the utilization of waste of as (*Pangasianodon hypophthalamus*) processing plants in the supplementary diets of tilapia fish (*Oreochromis niloticus*) in pond system to compare the growth performance of fishes with other two diets; one prepared in the laboratory with plant ingredients and another diet was purchased from market. In this study, feed formulated with pangas processing waste was named as Diet-2, feed formulated with plant source ingredients was named as Diet-3 while commercial feed which was purchased from market was named as Diet-1 and used as control Diet. These three diets were assigned to three treatments viz. T2, T3 and T1. Protein contents of diets were found 32.84%, 29.63% and 28.92% respectively. The water quality parameters (temperature, dissolved oxygen and pH) of the experimental ponds were monitored at 10 days of interval during the experimental period in different treatments. The results of the study showed that the weight increment for different treatments significantly varied and the highest weight gain in tilapia (175 ± 1.25 g) was found for Diet-2. The highest Specific Growth Rate (SGR; %/day) was 2.21% /day for Diet1. The Food Conversion Ratio (FCR) value obtained for Diet-2 (1.06) was lowest whereas Diet-3 (1.21) performed better than Diet-1 (1.16). The average protein efficiency ratio (PER) of Diet-2 (5.33) differed much compared to that of Diet-3 (5.21) and Diet-1 (5.56). The highest survival rate (%) of tilapia was 93.86%, found for Diet-2. The highest net production of tilapia was estimated 3879.2 kg/ha for Diet-2. To make the feed cost effective, inclusion of pangas processing waste along with other ingredients in tilapia diet (Diet-2) had a great significance. The calculated cost of each kilogram of Diet-2, Diet-3 and Diet-1 were 37.47 BDT, 42.10 BDT and 43.60 BDT, respectively. Based on the observation of present study, it could be recommended that, the waste materials from pangas processing plants can be better utilized as a source of protein in the diets of tilapia fish and at the same time it may contribute in reducing the environment pollution cased due to improper management of the fish industry.

Introduction

In our country pangas (*Pangasianodon hypophthalamus*) has become one of the most popular commercial species in last few years. Commercialization of pangas culture has led to profitable venture of processing industry. Pangas fish processing is concerned with proper waste management. About 70% of the fish is processed before final sale resulting in 20-80% of fish waste depending on the level of processing and type of fish (AMEC, 2003). Processing of fish involves stunning, grading, slime removal, de-heading, washing, scaling, gutting, cutting of fish, meat bone separation, and preparation of steaks and fileting. During these steps significant amount of waste is generated. Therefore, there is a need to find out ecologically acceptable means for reutilization of these wastes (Amin *et al*., 2011). In 2015, Love *et. al* stated that- waste reduction to zero waste is essential for environment and human health. In addition, the utilization of processing industry waste might provide extra income to the local workers.

Two types of culture system namely monoculture and poly-culture or composite culture are very popular in our country. Nile tilapia (*Oreochromis niloticus*) is widely cultured in tropical and subtropical areas of the world. In Bangladesh also tilapia is cultured extensively. For better growth of fish in culture system, diet has very important role. The role of animal protein in finfish diets cannot be over-emphasized as it supplies high amino acid profile required for fast growth and nourishment. While fish meal is used as the protein source in feed formulation, it is quite often so scarce and expensive that a suitable alternative has always been a prime concern. Variety of fish feed ingredients are available in Bangladesh. Some common fish feed ingredients are fish meal, fish silage, bone meal, cattle viscera, poultry viscera, fish viscera, frog waste etc. Most of fish feed ingredients are considered as protein supplements i.e. contains more than 20% protein (FRI, 1989). However, from the economic point of view, feed cost appears to be one of the major constraints against the greater

Cite this article

Hossain, M.I., Shikha, F.H. and Alam, M.M. 2020. Utilization of pangas (*Pangasianodon hypophthalamus*) processing waste in preparation of tilapia (*Oreochromis niloticus*) fish feed. *Journal of Bangladesh Agricultural University*, 18(2): 516–523. https://doi.org/10.5455/JBAU.95923

expansion of aquaculture (Kaushik, 1990). There is a great potential of reutilization of pangas processing waste in Bangladesh, if it could be done in a suitable and feasible method. This could also help boost up country's economy if proper attention paid to it.

Therefore, the objectives of the present study was to utilize the pangas processing waste in the preparation of tilapia (*Oreochromis niloticus*) feed for better utilization of the waste, minimizing the environmental pollution due to improper management of the waste and to compare the growth performances of tilapia in monoculture system using this laboratory prepared feed with the commercial fish feed and feed prepared with plant protein sources.

Materials and Methods

Duration and place of the study

The present study was undertaken for the period of three months from March to May, 2018 at the ponds of Faculty of Fisheries, Bangladesh Agricultural University.

Selection and collection of feed ingredients

The feed ingredients which were selected to carry out the experiment were collected from local market. Different types of feed ingredients such as rice bran, maize, soybean, wheat bran, molasses, vitamins and minerals premix were purchased from local market of Mymensingh. The main ingredient pangas waste (skin, fat, bladder, bone and stomach) were collected from 7-Ocean fish processing industry situated at Trishal, Mymensingh

Feed formulation and preparation

For performing this experiment, two types of diets such as Diet-2: formulated feed with pangas waste and Diet-3: formulated feed without pangas waste/formulated feed with plant ingredients, were formulated. The commercial feed was used as control and purchased from the local market.

Preparation of Diet-2 (formulated feed with pangas waste)

The experimental Diet-2 was prepared by using pangas waste and other ingredients which were brought from the market (Table 1). The collected wastes were first washed, dried under the sunlight and milled. The selected ingredients were mixed thoroughly. Mixing of ingredients was performed by hand before adding water with stirring to form dough. Finally, mixture made into pellets using a pellet machine. The pellets were sundried. The pellets were packed in air-tight water impermeable bags and stored in dry and cool place. The flow diagram of the preparation procedure of Diet-2 is shown in Fig. 1.

Table 1. Formulation of Diet-2 (formulated feed with pangas waste) and Diet-3 (formulated feed without pangas waste)

Feed ingredients	Percentage of Ingredients	
	Diet-2	Diet 3
Pangas waste	40.00	-
Soybean meal	24.00	48.00
Rice bran	10.00	12.00
Wheat bran	10.00	12.00
Maize	13.00	25.00
Molasses	2.00	2.00
Vitamin & mineral mix	0.40	0.50
Salt	0.60	0.50
Total	100.00	100.00

The supplementary Diet-3 was formulated in the laboratory without using pangas waste (Table 1). All ingredients (except pangas waste) were weighed accordingly. As in Diet-3, pangas waste was not used, therefore to make the total volume 100, the other ingredients (soybean meal, rice bran, wheat bran, maize etc.) were used in increased amount. Measured ingredients were mixed thoroughly in desired proportions. Pellets were prepared using a mechanical hand pelletizer machine with a 2 mm diameter grid. The formulation protocol of Diet-3 was similar as followed for Diet-2.

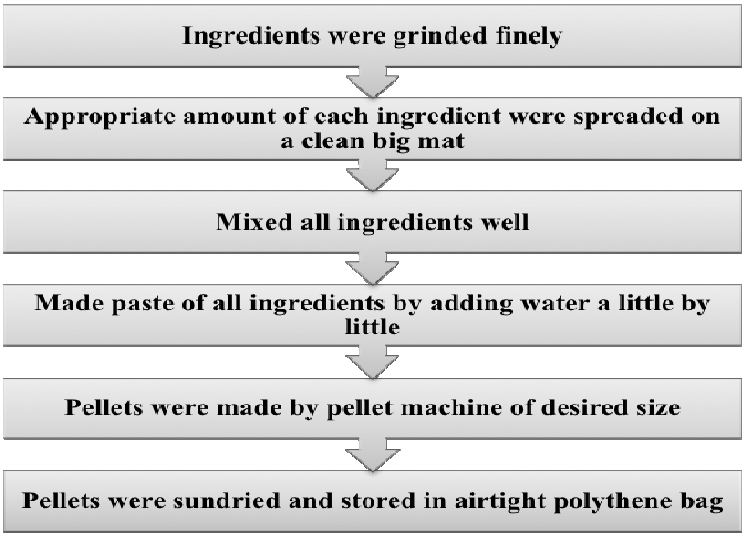

Fig. 1. Flow diagram for preparation of Diet-2 (Formulated feed with pangas waste)

Plate 1. Three experiment diets (A) Diet-1, (B) Diet-2, (C) Diet-3 used in the experiment

Commercial feed

Commercial feed used to carry out this experiment was used as a control (Diet-1). It was purchased from the distributor of Krishibid Feed Limited which particularly known as Mega Feed Limited.

Feed management and feeding rates

The feed was supplied daily at the rate of 5% of fish body weight for the first month and then the feeding rate gradually reduced to 4.5% in the next two weeks and 4% in last two weeks. Feeding rates were adjusted on the basis of fish weight gain at 10 days interval. The daily ration was divided into two parts. About half of the ration applied in the morning between 8.30 to 9.30 am and another half in the afternoon between 4:30 to 5:30 pm.

Sampling of fish and water quality parameters

Sampling of fish was done at ten days interval to observe the growth of fish and to adjust the feeding rate. Weight of fish was measured by using a electronic balance. Some important water quality parameters such as water temperature (ºC), dissolved oxygen (mg/l) and pH were measured during the periods of sampling. The sample collection was done between 8.30 to 9.30 am.

Analytical methods

Proximate composition of all individual feed ingredients and prepared feeds from those ingredients were analyzed in the Fish Processing Laboratory of the Department of Fisheries Technology, BAU following the methods of the Association of Official Analytical Chemists (1995) with slight modification.

Weight Gain (WG), Survival Rate (SR) and Food Conversion Ratio (FCR) of experimental fishes were measured using the following formulae (Samad A P A *et al*., 2014):

Weight gain (WG, %) = 100 x [(final weight (g) – initial weight (g)] / initial weight (g)
Survival rate (SR, %) = (Final no. of fish / initial no. of fish) x 100
Feed conversion ratio (FCR) = dry feed intake (g)/ [final body weight (g) – initial body weight (g)]
On the other hand, Specific Growth Rate (SGR) and Protein Efficiency Ratio (PER) were measured using the following formulae (Oh S Y *et al*., 2013).

Specific growth rate (SGR, % day-1) = 100 × (lnWf – lnWi)/t
Protein efficiency ratio (PER) = (Wf– Wi)/D
Where, Wf and Wi are final and initial weights (g), t is the experimental duraion (day and D is crude protein intake.

Data analysis

Data obtained from the present study were analyzed to assess the composition of different feed ingredients and prepared diets. Data was entered into the MS Excel and simple statistics such as range, mean, standard deviation were done.

Results

Proximate composition of experimental diets

The proximate composition of different experimental diets including the control (commercial feed) were analyzed which is shown in Table 2 (percent carbohydrate and fiber contents in diets were not calculated, thus were not presented in the table). There was a slight variation in protein, lipid, ash and moisture content of different diets. The protein content of different diets varied between 28.92% to 32.84% and the Diet-2 contain the highest value (32.84%). The lipid content varied between 5.65% to 12.53% while the highest lipid content (12.53%) found in Diet-2 and the lowest lipid content (5.65%) was found in Diet-1. The highest ash content (12.83%) was found in Diet-2 and lowest ash content (10.17%) was found in Diet-1. The moisture content also varied in diets from 8.21% to 11.31%.

Table 2. Percent (%) moisture, crude protein, lipid and ash contents of the experimental diets

Contents (%) in Diets	Treatments		
	Diet 1	Diet 2	Diet 3
Moisture	11.31	8.21	10.52
Crude Protein	28.92	32.84	29.63
Lipid	5.65	12.53	5.89
Ash	10.17	12.83	11.53

Water quality parameters

During the study period the mean value of the temperature measured in different treatments ranged from 25.5^{0}C to 29.3^{0}C (Table 3). The minimum temperature (25.5^{0}C) and the maximum temperature (29.3^{0}C) were observed in March and May, respectively

in pond 3. During the experimental period, the mean value of the DO (mg/l) in the different treatments ranged from 3.48 mg/l to 5.32 mg/l (Table 3). The highest DO concentration (5.32 mg/l) and the lowest DO concentration (3.48 mg/l) were observed in pond 3 on March and May, respectively. The mean value of pH of sub-surface water in the experimental ponds during the study periods varied from 6.73 to 8.21 (Table 3). The highest pH value 8.21 was recorded in pond 2 on May and the lowest value 6.73 was observed in pond 1 on March.

Table 3. Monthly variation in the ranges and mean value of water temperature (^{0}C), of dissolved oxygen (DO, mg/l) and pH in different experimental ponds

Parameter	Months	Treatments		
		Pond 1 (Mean±SD)	Pond 2 (Mean±SD)	Pond 3 (Mean±SD)
Temperature (^{0}C)	March	25.6 - 27.6 (26.6 ± 0.98)	25.9 - 27.7 (26.8 ± 0.92)	25.5 - 27.2 (26.35 ±0.18)
	April	27.2 - 28.8 (28 ± 0.75)	27.5 - 28.6 (28.1 ± 0.88)	26.7 - 29.2 (28.1 ± 1.15)
	May	27.2 - 28.8 (27.8 ± 0.79)	27.4 - 28.8 (28.1 ± 0.65)	27.2 - 29.3 (28.2 ± 1.01)
Dissolved Oxygen (DO, mg/l)	March	3.56 – 5.21 (4.57 ± 0.71)	3.67 – 5.15 (3.86 ± 0.30)	3.94 – 5.32 (4.78 ± 0.61)
	April	3.65 – 4.91 (4.23 ± 0.63)	3.65 – 4.21 (3.85 ± 0.30)	3.55 – 4.84 (4.05 ± 0.67)
	May	3.57 – 4.68 (4.18 ± 0.56)	3.65 – 4.54 (4.02 ± 0.44)	3.48 – 4.71 (4.12 ± 0.61)
pH	March	6.73 – 7.29 (7.01 ± 0.32)	6.87 – 7.17 (7.02 ± 0.24)	6.89 – 7.21 (7.05 ± 0.15)
	April	7.78 – 7.91 (7.83 ± 0.06)	7.68 – 7.87 (7.78 ± 0.09)	7.68 – 7.89 (7.78 ± 0.11)
	May	7.87 – 8.21 (8.01 ± 0.15)	7.76 – 7.87 (7.81 ± 0.05)	7.79 – 8.11 (7.92 ± 0.16)

Growth performance of experimental fishes

Growth performance of tilapia in different treatments in terms of mean weight gain, (%) weight gain, weight increment in every 10 days, FCR, PER were calculated.

Mean weight gain

The mean weight gain of tilapia during experimental period in different treatments was found different (Fig. 2). The highest weight gain in tilapia was observed for Diet 2.The lowest weight gain among these three treatments was found for Diet 3. The study revealed that, the weight gain in different treatments of tilapia ranged from 154.46g to 175.20g, respectively during the three months of study period.

Weight increment of experimental fish tilapia

The highest weight increment (g) was found 180.4 for Diet-2 and the lowest weight increment (g) was 157.6 found for Diet-3. The weight increment (g) was checked every 10 days interval during the experiment period of tilapia in mono-culture system. The obtained results are shown in Fig. 3.

Percent weight gain

The percent (%) weight gain was significantly different in three different diets. The highest percent (%) weight gain was found 1445.94 for Diet 2 (formulated diet with pangas waste). The values of percent weight gain in different treatments were shown in Fig. 4.

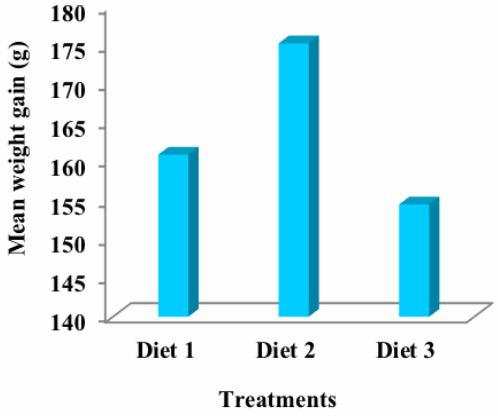

Fig. 2. Comparison of weight gain (g) of tilapia (*O. niloticus*) in different treatments during the experimental period

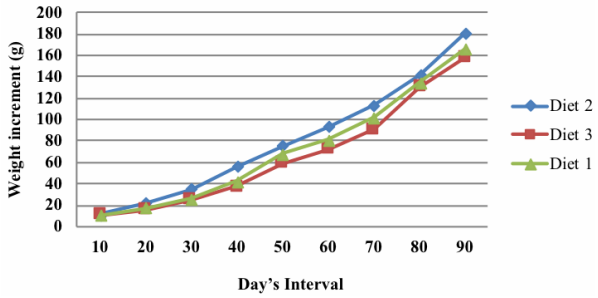

Fig. 3. Weight increment (g) of tilapia (*O. niloticus)* in different treatments during the experimental period

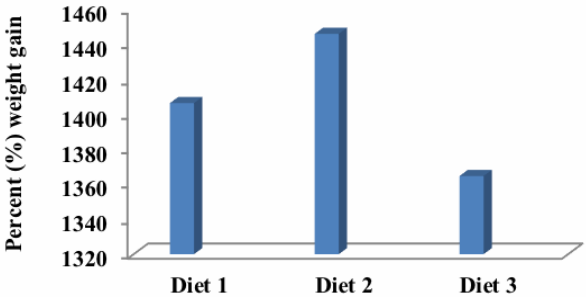

Fig. 4. Percent (%) weight gain of tilapia (*O.niloticus*) in different treatments during the experimental period

Specific growth rate

The specific growth rate (SGR, %/day) of tilapia in different treatments ranged from 2.08% to 2.40%. The highest specific growth rate (%/day) value was obtained in tilapia 2.40% for Diet-2.The specific growth rate (%/day) of different treatments is shown in Fig. 5.

Feed conversion ratio (FCR)

Mean feed conversion ratios (FCR) were different in treatments and ranged from1.06 to 1.21 (Fig. 6). The best FCR value was observed in Diet 2 (1.06 ± 0.12) where Diet 1 (1.16 ± 0.13) showed comparatively better result than Diet 3 (1.21 ± 0.13). There were significant variations in FCR value among the treatments.

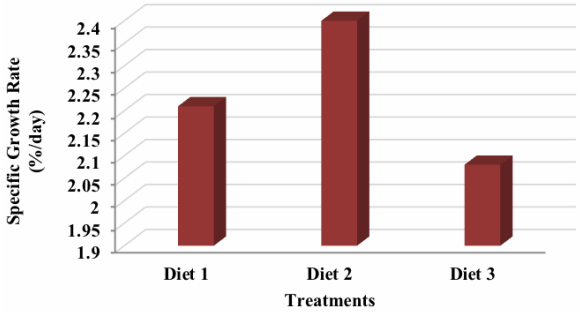

Fig. 5. Specific Growth Rate (SGR, %/day) of tilapia (*O. niloticus*) different treatments during the experimental period

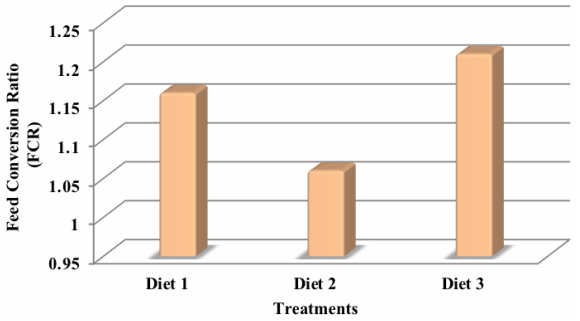

Fig. 6. Mean FCR of diets in different treatments during the experimental period

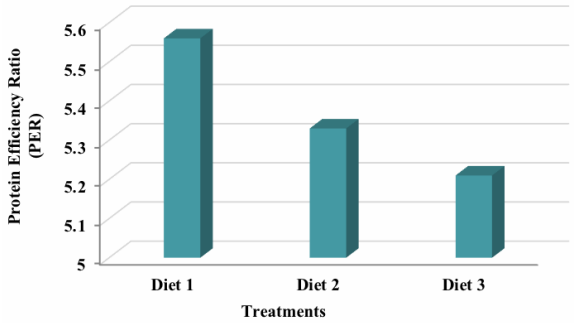

Fig. 7. Comparison of mean PER in different treatments during the experimental Period

Protein efficiency ratio

Mean protein efficiency ratio (PER) varied in different treatments from 5.21 to 5.56 (Fig. 7). There were clear variations among the treatments. The best PER value was obtained with Diet 1 (5.56) while Diet 2 (5.33) showed comparatively better result than Diet 3 (5.21) among the three different treatments.

Survival rate

The survival rate (%) of tilapia fish in different treatments was fairly high. The highest survival rate (%) tilapia (*O. niloticus)*was found 93.86 for Diet-2 (Fig. 8).

Estimation of fish production

Total net production of fish in terms of kg/ha during the experimental period is shown in Table 4. The highest total net production of tilapia (*O. niloticus*) was estimated 3879.13 kg/ha for Diet-2 and the highest total net production was calculated 1267.97 kg/ha for Diet 1.

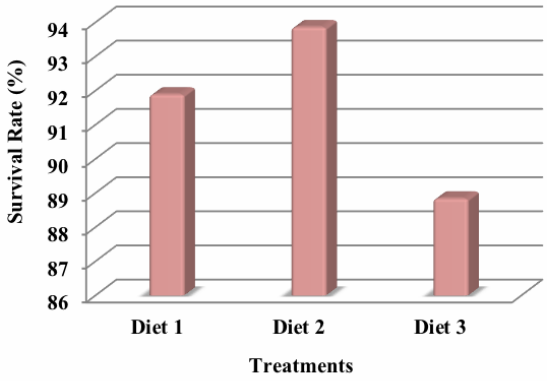

Fig. 8. Comparison of survival rate (%) of tilapia (*O. niloticus)* in different treatments during the experimental period

Table 4. Total net production of fish in terms of kg/ha during the experimental period

Treatments	Gross production (kg/ha)	Net production (kg/ha)	Total net prod. (kg/ha)
	Tilapia	Tilapia	
Diet-1	1195.87	1267.97	3749.72
Diet-2	1325.27	1127.58	3879.13
Diet-3	1112.56	997.36	2997.04

Cost analysis of formulated diets

Pangas waste is a good source of protein, lipid, crude fiber and minerals. Pangas waste along with other ingredients in finfish diet bears a great significance to minimize the feed cost. Diet-1 (prepared by Krishibid Feed Limited) is the commercial feed which is used widely in Bangladesh for finfish monoculture/polyculture. This feed was brought directly from the whole sell market. The cost of one sack (25 kg) feed was 1090 BDT. The calculated price including carrying cost was 43.60 BDT/kg. The estimated per kilogram cost of two formulated diets and the cost of per kilogram commercial diet are shown in Fig. 9.

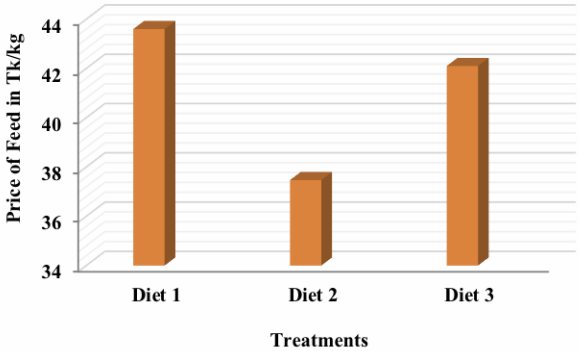

Fig. 9. The graphical presentation of price of three different experimental diets

Discussion

Proximate composition of diets

In the present study comparatively higher values were obtained for protein and lipid content in Diet-1 than Diet-3, whereas the highest values were observed in Diet-2. The reason of highest value in percent protein and lipid in Diet-2 than other two diets might be due to the presence of higher percentage of protein and fat in

the waste materials of pangas processing industry. Hernández *et al.,* (2013) reported percent crude protein 44.8 and crude lipid 1.26 in defatted soybean meal and percent crude protein 57.2, crude lipid 13.9 in tuna by-product meal used in digestibility and growth performance study of tilapia fingerlings indicating the presence of higher protein and lipid content in the waste materials of fish processing industry which support the findings of the present study.

Water quality parameters

Temperature plays significant role in fish production. Boyd (1982) reported that, the range of water temperature from 26.06 to 31.97°C is suitable for fish culture. Mollah and Haque (1978), Rahman *et al*., (1982), Dewan *et al*., (1991), Wahab *et al.*, (1995) reported the surface water temperature ranged from 30.2-34°C in polyculture of Indian and Chinese carps. These reports are more or less similar to the observation of the present study during the months of March to May.

Banerjee (1967) reported that oxygen concentration above 5 mg/l is indicative of productivity. Roy (2001) also found, 5.0 to 7.0 mg/l of dissolved oxygen content of water is fair or good in respect of productivity. The obtained data throughout the study period are more or less agreed with the previous findings.

The pH of water is a measure of hydrogen ion concentration and indicator of the water quality. Hossain (2000) found a good relationship between pH of pond water and fish culture and obtained satisfactory results at pH 6.5 to 9.0. DoF (1998) also reported that, pH 5 to 8 is good for fish culture. Mean pH values of present study in different month in different treatments were in the suitable range as observed in other studies thus contributed in the growth of tilapia.

Mean weight gain

Among three different diets the lowest mean weight gain was obtained for Diet-3 and highest weight gain for Diet-2 and highest weight gain for Diet-1. Bahnasawy *et al*., (2003) carried out a study on growth performance of Nile tilapia (*O. niloticus*) fingerlings raised in an earthen pond fed with supplemental feed (25% crude protein) at 50% satiation. In their study they found the mean weight of harvested fish ranged from 110 to 250 g. These mean weight gain are quite nearer to the values obtained in the present study. Ahmed *et al.,* (2013) observed best weight gain123.48 g fed homemade feed formulated with fish meal and111.82 g with commercial feed for monosex tilapia (*O. niloticus*) in earthen mini ponds which are similar in trend with the present study

Weight increment

Ahmed *et al*., (2013) reported best weight gain 123.48 g in T1 (Treatment 1) than T2 (Treatment 2) 111.82 g where in T1tilapia fishes were fed homemade feed with Peninsula Group fish meal and in T2 fishes were fed commercially available feed. These values are little lower than the weight increment (g) values of the present study and this is might be due the differences in diet quality and duration of rearing of the fishes.

Percent weight gain

Zafar *et al.,* (2017) studied the growth and production of monosex tilapia (*O. niloticus*) under different feeding frequencies in pond conditions and observed percent weight gain 5678.65, 5167.54 and 4293.27 in T1, T2 and T3, respectively where feeding frequency was four times in a day (T1), three times in a day (T2) and two times in a day (T3) were used. These percent of weight gain of tilapia is significantly higher than the percent (%) weight gain found in the present study which might be due to the frequency of feeding and differences in feed ingredients of feeds used.

Specific growth rate

Bilale and Teklie (2017) carried out a study to investigate the effect of brewery waste on the growth performance of Nile tilapia in concrete ponds in Ethiopia. The treatment groups were fed at 5% of their body weight twice daily with locally available brewery waste for 180 days whilst the control group was fed only on natural food items. After the study period, they found the specific growth rate of the Nile tilapia in treatment groups (1.25 ± 0.02) was better than the control groups (0.88 ± 0.01). Hasan *et al.,* (2010) carried out a study on the effects of stocking density on growth and production of GIFT (*O. niloticus*).for a period of 100 days with stocking densities of 150, 200 and 250 fish/decimal as T1, T2 and T3, respectively. They reported the specific growth rates (SGR) at every 10 days ranged from 6.59 to 1.11 in different treatments during the experimental period. Specific growth rates obtained in the present study for different diets are more or less similar to the findings of other researches.

Feed conversion ratio

The mean FCR value ranging from 1.06 to 1.21 in different treatments of the present study are comparable with the findings of other researchers. El-Sayed (2013) attained feed conversion ratios (FCR) in the range of 1.5:1 to 2.5 using pelleted feeds while for extruded feeds FCR value ranged from 1.1:1 to 2:1in a study done in Egypt about feed management practices for Nile tilapia (*O. niloticus*) on-farm. Ahmed *et al* (2013) carried out a research on the growth and production performance of monosex tilapia (*O. niloticus*) fed with homemade feed in earthen mini ponds and observed the food conversion ratio (FCR) 1.51 for feed prepared with fish meal and 1.40 for commercial feed.

Protein efficiency ratio

Sweilum (2005) found highest protein efficiency ratio (2.15) in a study carried out a study on the growth performance, feed efficiency and digestibility for Sarotherodon galilaeus (*Tilapia galilae*) reared with two different initial weights of 20 and 50 g in concrete ponds (8 m2 area for each). Ogunji *et al.,* (2008) reported protein efficiency ratio between 2.21–2.47 in a research

done on the growth performance, nutrient utilization of nile tilapia (*O. niloticus)* fed housefly maggot meal (Magmeal) diets. The present study the mean PER value ranged from 5.21 to 5.56 in different treatments during the experimental period which were little higher than the above findings.

Survival rate

Herawati *et al.,* (2015) in their study on growth and survival rate of tilapia (*O. niloticus*) larvae fed by *Daphnia magna* cultured with organic fertilizer resulted from probiotic bacteria fermentation found survival rate 98.46%. Hossain *et al.,* (2017) reported the highest survival rate in treatment-4 (92.8%) fed with mixed diet and the lowest in treatment-3 (88.4%) fed with *Chlorella vulgaris* after 24 weeks of culture in a study on growth performances and fatty acid profile of nile tilapia (*O. niloticus)* fed with different phytoplankton. In present study the survival rate (%) ranged from 88.84-93.86%which were more or less similar with the above findings.

Cost analysis of formulated diets

The high protein content in the naturally available feeds provides an inexpensive feed supplement during the initial grow-out period suggested by Edwards (2009) which was agreed with the result. Dorsa *et al.*, (1982); Ofojekwu and Ejike (1984) reported that, feeds from plant origin have been reported to be effective and less expensive ingredients to fish diets. In Diet-2 and Diet-3, pangas waste and plant based protein especially soybean meal was used as protein supplement respectively. Patnaik and Das (1979) observed that, in the recent years, feeds from plant origin have been accepted for Indian major carps as the growth in fishes has been reported to be as good as the traditional feed.

Conclusion

It can be concluded that, inclusion of pangas waste along with other available low cost ingredients in tilapia diet not only provides better protein percentage in the diet but also minimize the feed production cost in a significant margin.

References

Ahmed G U, Sultana N, Shamsuddin M. and Belal Hossain M. 2013. Growth and Production Performance of Monosex Tilapia (*Oreochromis niloticus*) Fed with Homemade Feed in Earthen Mini Ponds. *Paki. J of Biol. Scie*., 16 (3): 1781-1785. https://doi.org/10.3923/pjbs.2013.1781.1785

Amin A M, Ashikin S N and Faazaz A L. 2011. Optimization of enzymatic protein hydrolysis from silver catfish (Pangasius sp.) frame. *Int. Food Rese. Jorn.*, 18(2)

AMEC. 2003. Management of wastes from Atlantic seafood processing operations. AMEC Earth and Environment Limited, Dartmouth, Nova Scotia, Canada.

AOAC. 1995. Official methods of analysis of the Association of Official Analytical Chemist -Washington D.C. 13th ed.

Bahnasawy M H, Abdel-Baky T E, Abd-Allah G A. 2003. Growth PE performance of Nile tilapia (*Oreochromis niloticus*) fingerlings raised in earthen pond. *Archi, of Polis Fish.*, 11 (2) : 277-285.

Banerjee S M. 1967. Water quality and soil condition of fish ponds in some states of India in relation to fish production. *J of Indi. Fish. Soci.*, 5: 162-170.

Bilale A M and Teklie A T. 2017. Evaluation of growth performance of Nile tilapia (*Oreochromis niloticus*, Linnaeus, 1752) with supplementary feeding of brewery waste in concrete ponds at Tehuledere district, Amhara Region, Ethiopia. *Int. J of Fish. and Aqua. Stud.*, 5(4): 295-299.

Boyd C E. 1982. Water quality management for pond fish culture. Elsevier Scientific Publishing Company, Amsterdam, Netherlands, pp. 318.

Dewan S, Wahab M A, Beveridge M C M, Rahman M H and Sarker B K.1991. Food selection, electivity and dietary overlap among plantivorous Chinese and Indian major carps fry and fingerlings grown in extensively managed, rain-fed ponds in Bangladesh, *Aqua. and Fish. Mana.*, 22: 227-294. https://doi.org/10.1111/j.1365-2109.1991.tb00518.x

DoF. 1998. Matshya Saptah Shankalan, Directorate of Fisheries, Bangladesh.

Dorsa W J, Robinson E H and Poe W E. 1982. Effect of dietary cottonseed meal and gossypol on growth of young channel catfish. *T of the Amer. Fish. Soci*., 3: 651-655. https://doi.org/10.1577/1548-8659(1982)111%3C651:EODCMA%3E2.0.CO;2

Edwards P. 2009. Traditional Asian Aquaculture. In. Burnell G & Allan G (eds.) New Technologies in Aquaculture. Woodhead Publishing Limited, Cambridge, 1029-1063. https://doi.org/10.1533/9781845696474.6.1029

El-Sayed A F M. 2013. On-farm feed management practices for Nile tilapia (*Oreochromis niloticus*) in Egypt. In M.R. Hasan and M.B. New, eds. On-farm feeding and feed management in aquaculture. FAO Fisheries and Aquaculture Technical Paper No. 583. Rome, FAO. pp. 101–129.

FRI. 1989. Survey of potential fish feed ingredients of Bangladesh on the basis of their availability and biochemical composition, Research Project Report No. 1, Fisheries Research Institute, Mymensingh, Bangladesh.

Hasan S J, Mian S, Rashid A H A and Rahmatullah S M. 2010. Effects of stocking density on growth and production of GIFT (Oreochromis niloticus). Bang. Fish. Res., 14(1-2): 45-53.

Herawati V E, Hutabarat J, Pinandoyo and Radjasa O K. 2015. Growth and survival rate of tilapia (*Oreochromis niloticus*) larvae fed by daphnia magna cultured with organic fertilizer resulted from probiotic bacteria fermentation. HAYATI J of Bios., 22:169-173. https://doi.org/10.1016/j.hjb.2015.08.001

Hernandez C, Miguel A O N, Domenico V, Ronald W H, Blanca G R, Patricia D J, Martin

V R and Samuel A R. 2013. Use of tuna industry waste in diets for Nile tilapia, *Oreochromis niloticus*, fingerlings: effect on digestibility and growth performance. *Lati Amer. J of Aqua. Resea*. 41(3): 468-478.

Hossain M Y. 2000. Effects of iso-phosphorus organic and inorganic fertilizer on water quality parameters and biological production, MS Thesis, Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh.

Hossain M B, Sultana N, Noor P, Khan S, Lisa S A, Begum M, Punam N J, Begum M K, Hasan M R and Rahman M S. 2017. Growth performances and fatty acid profile of Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) fed with different phytoplankton Dha *Dhak. Univ. J. Biol. Sci.,* 26(1): 13–27. https://doi.org/10.3329/dujbs.v26i1.46346

Kaushik S. 1990. Use of alternative protein resources for the intensive rearing of carnivorous fish, In: Mediterranean aquaculture (Editors Flos R, Tort L and Torres P). pp. 125-138.

Mollah M F A and Haque A K M A. 1978. Studies on monthly variations of plankton in relation to the physico-chemical conditions of water and bottom soil of two ponds. II. Zooplankton. *Bang. J. Fish.* 1: 99-103.

Ofojekwu P C and Ejike C. 1984. Growth response and feed utilization in the tropical (*Oreochromis niloticus*) fed on cottonseed based artificial diets. *Aquacult,*, 4: 27-36. https://doi.org/10.1016/0044-8486(84)90310-7

Ogunji J, Toor R S, Schulz C and Kloas W. 2008. Growth performance, nutrient utilization of Nile tilapia Oreochromis niloticus fed housefly maggot meal (Magmeal) diets. Turki. J of Fish. and Aqua. Scie., 8: 141-147.

Oh S Y, Kim M S, Kwon J Y, and Maran B A V. 2013. Effects of Feed Restriction to Enhance the Profitable Farming of Blackhead Seabream Acanthopagrus schlegelii schlegelii in Sea Cages. Ocea Sci. J., 48(3):263-268. https://doi.org/10.1007/s12601-013-0024-z

Patnaik K S and Das K M. 1979. Utilization of some aquatic weeds as feed for rearing Carp spawn and fry. In Proceedings of the Symposium on Inland Aquaculture. Central Inland Fisheries Research Institute, Barracpore, India, 12.

Rahman M S, Chowdhury M Y, Haque M A and Haq M S.1982. Limnological studies of four ponds. *Bang. J. Fish*., 2-5: 25-35.

Roy K. 2001. Effect of stocking density on the growth of carps in ponds, MS Thesis, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh.

Samad A P A, Hua N F and Chou L M. 2014. Effects of stocking density on growth and feed utilization of grouper (Epinephelus coioides) reared in recirculation and flow-through water system. Afric. J of Agril. Res, 9(9): 812-822. https://doi.org/10.5897/AJAR2013.7888

Sweilum M A. 2005. Growth performance, feed efficiency and digestibility of *Sarotherodon Galilaeas* fed on artificial diets varied in protein and energy rates. *Egypt. J. Exp. Biol. (Zool.)*, 1: 41 – 46.

Wahab M A, Ahmed Z F, Islam A and Rahmatullah S M. 1995. Effect of introduction of common carp, Cyprinus carpio (L) on the pond ecology and growth of fish in polyculture. *Aquacult.* Res. 26: 619-628. https://doi.org/10.1111/j.1365-2109.1995.tb00953.x

Zafar A, Karim M and Ali M. 2017. Growth and Production of Monosex Tilapia (*Oreochromis niloticus*) Under Different Feeding Frequencies in Pond Conditons. *J of Aqua. & Mari. Biol.*, 6 (5). https://doi.org/10.15406/jamb.2017.06.00167