Journal of
Fisheries and Aquatic Science

ISSN 1816-4927

Academic
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www.academicjournals.com

OPEN ACCESS Journal of Fisheries and Aquatic Science

ISSN 1816-4927
DOI: 10.3923/jfas.2018.1.11

Research Article
Effects of Commercial Feeds on the Growth and Carcass Compositions of Monosex Tilapia (*Oreochromis niloticus*)

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Abstract

Background and Objective: Many commercial foods are introduced for monosex tilapia culture. The present study want to know their efficiency in composition and on the growth of tilapia. **Materials and Methods:** This study was continued on total 300 monosex tilapia, (*Oreochromis niloticus* L.) through 16 weeks under four treatments (T) with triplication of four different feed variety (Quality Feed Ltd, Aftab Feed Ltd, Mega Feed Ltd and controlled feed) and same stocking density (initial mean weights = 6.05±0.31g). The experimental feeds were supplied twice daily (9.00 AM and 4.00 PM) at the rate of 5% of the body weight. **Results:** During the study period, the water quality parameters (water temperature: 29.04±2.36°C, DO: 5.81±0.12, pH: 7.18±0.04, NO_3-N: .11±0.03 and PO_3-P: 0.08±0.03) were similar and remained within the suitable range for fish growth (survival rate = 100%). Significantly higher mean weight gain was recorded in T_3 (19.06±0.89 g) over the other treatments ($p>0.05$) and the lower was in T_4 (12.10±1.12 g). The maximum specific growth rate was recorded in T_3 (1.25±0.09 %) whereas the minimum in T_4. Significantly higher carcass protein and ash content was recorded in $T_3>T_1$, $T_2>T_4$. The carcass lipid contents showed $T_2>T_1$, $T_4>T_3$. **Conclusion:** The present study demonstrated that using mega feed (T_3) increased (growth and carcass compositions' significance, $p>0.05$) the growth whereas using aftab feed (T_2)increased carcass protein content in compare to other commercial feeds.

Key words: Commercial feed, stocking density, carcass composition, weight gain, *Oreochromis niloticus*

Citation: Alok Kumar Paul, Mohammad Moshiur Rahman, Mohammad Mahabubur Rahman and Mohammad Shahanul Islam, 2018. Effects of commercial feeds on the growth and carcass compositions of monosex tilapia (*Oreochromis niloticus*). J. Fish. Aquat. Sci., 13: 1-11.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Considering the land area, Bangladesh is one of the smallest agriculture based economic country in the third world. Fisheries are one of the rich potential sectors of agriculture. Fish and fisheries have linked to the development of the human's earliest civilization. Even since, the fishes have been of considerable nutritional importance and human society has extended to culture aspects of food, behavior, belief and religion[1]. Fish has long been used as the cheapest source of protein for human nutrition worldwide-still with a gap in production and supply[2].

Hence, accelerating the development of aquaculture industry is one of the important factors to fulfill the protein demand for increasing world's population. Alongside, aquaculture success depends on quality and quantity of water[3]. It is fortunate that Bangladesh is a semiarid region, water quality is more or less determines success of fish culture. Moreover, the presence of quality feed with low cost is one of the important factors for successful aquaculture [4]. However, fish feed is widely recognized as the most expensive component among all the operational cost in fish farming. For feeding purpose, commercial fish farmers mostly depended on formulated feeds.

To meet up the demand of fish feeds, there are 48 national and multinational fish feed manufacturing companies currently operating their business in Bangladesh. Most of the fish feed manufacturing companies are trying to deliver their best product in the market with a good feed conversion rate. Among the multinational feed manufacturing companies, ACI Godrej Agrovet Pvt Ltd. has taken a significant market share within a very short time. Among the both national and multinational fish feed manufacturing companies Quality Feeds Limited is still now at the top position with a big market share. Using commercial feed, the survival rate of fish is in good range i.e., 76.5% for Nile tilapia (*Oreochromis niloticus)* reported by Hasan *et al.*[5]. They also reported that the average growth was 14.29% during 70 days trial. After this, the present study wants to use different commercial feed and controlled feed to observe the growth as well as carcass compositions of tilapia.

Tilapia was first introduced in Bangladesh in 1954. It has distributed various water to so many different types of culture systems in the world that they have been even labeled as the "aquatic chicken"[6]. Like other aquaculture species, feed manufacturing companies have developed tilapia feeds in different trade names with different nutritional compositions. Those manufacturing companies promoted their feeds in different angles with their own investigated evidence. However, the good composition of feed depends on the environmental condition and water parameters but the justifications and comparisons of the effect of these feeds on the growth and carcass compositions of fish in scientific laboratory are not available. A certain number of study have been carried out to evaluate the effect of fish feeds on the growth and carcass compositions of different fish species[7-10] but comparative study on different commercial feed based are so scare. Therefore, the present study was carried out about the utilization of commercial feed and its effect on the growth and carcass compositions of monosex tilapia (*Oreochoromis niloticus*). Significant food composition and carcass ratio may be founded by this study.

MATERIALS AND METHODS

Time and location of the study: The study was carried through 16 weeks feeding trail from 17 July-17 November, 2014 at the wet laboratory in the Department of Fisheries, University of Rajshahi, Rajshahi, Bangladesh.

Experimental unit: The experiment was carried out in glass aquariums (90×30×30 cm, 80 L) with continuous water supplying and water exchanging facilities. The aquariums were well aerated by the aerator (Model AC-980) and covered with fine net to avoid jumping of fish.

Experimental feeds: Three commercial feeds (quality feed Ltd, aftab feed Ltd and mega feed Ltd) and one homemade feed (control feed) were used as experimental feeds. The commercial feeds were collected locally and the homemade feed made of three ingredients: Rice bran, rice flour and mustard oil cake (about 40% crude protein) by using manually operated pellet machine.

Experimental design: The experiment was conducted in glass aquariums under four treatments viz. treatment-1(T1), treatment-2 (T2), treatment-3 (T3) and treatment-4 (T4) with three replicates in each treatment. All fishes of T1 segment treated with quality feed (feed-1) and accordingly T2, aftab feed (feed-2), T3, mega feed (feed-3) and T4 with homemade feed (control feed, feed-4).

Rearing of fish: Fingerlings of monosex tilapia (same aged group) were procured from local fish breeding farm in Rajshahi and were brought to the laboratory in the oxygen

packed plastic container. The fishes were acclimatized in the laboratory condition for 7 days in glass aquaria. They were starved for 24 h, prior to the onset of experiment. A total of 300 fish fingerlings were stocked at the rate of 25/aquarium. The fishes were fed daily (two times) at 5% of body weight throughout the study tenure. The water was replenished every day to avoid accumulation of unutilized feeds and metabolic wastes of the fish. The leftover feed materials were collected and dried in incubator at 60°C for 24 h. The dried materials were weighed to measure feed intake.

Monitoring of physico-chemical parameters: During the study period, some physico-chemical parameters viz., water temperature (Celsius thermometer), dissolved oxygen (DO), pH (HANNA DO and pH meter, model: HI-9142), nitrate-nitrogen (NO_3-N), ammonium-nitrogen (NH_4-N) and phosphate-phosphorus (PO_4-P) were measured (HACH Kit (DR/2010 model) and monitored weekly.

Sampling and harvesting of fish: After successive intervals of 3, 6 and 9 weeks, body weights of experimental fish were measured using digital electric balance. After 12 weeks of feeding trail, all fishes were harvested and the weights were measured. Five fishes were selected randomly from each experimental aquarium and were decapitated to collect muscles for analyzing carcass composition. The fish carcass was dried at 60°C and blended, then was kept in desiccators jar for subsequent study.

Analysis of growth and feed utilization: The growth performance and feed utilization in terms of mean weight gain[11] (MWG), specific growth rate[11] (SGR), feed intake[12] (FI), feed conversion ratio[13] (FCR) and survival rate[11] were analyzed by using standard methods.

Chemical analysis: Standard methods of AOAC[14] were followed to measure carbohydrate ash and moisture content as well as the crude protein[15] and crude lipid[16] of dried homemade feed, formulated feeds and carcass of fish at the Nutrition Laboratory, Department of Aquaculture, BAU, Mymensingh, Bangladesh.

Statistical analysis: For data analysis of proximate composition and carcass composition with their physico-chemical parameters, one-way analysis of variance was performed by using computer software SPSS version 18.0. Significance was assigned at the 0.05 level. The mean values were compared to see the significant difference from the DMRT (Duncan Multiple Range Test). Linear regression, correlation and covariance were performed by Microsoft Office Excel 2016.

RESULTS AND DISCUSSION

Proximate compositions of formulated feeds: In tilapia and other fish culture, nutrition obviously plays significant role in the maintenance of a healthy and marketable product. Kpundeh *et al.*[17] conducted a study on the effect of dietary protein level on growth performance of genetically improved farm tilapia, (*Oreochoromis niloticus*). The nutrient balance of feed influences feed utilization and growth of fish. El-Dahhar *et al.*[18] also carried out a study to determine the optimum protein ratio for maximum growth, diet utilization and body composition of juvenile Nile tilapia (*Oreochoromis niloticus*). Continuing these growth observations, the present study used three commercial feeds and a homemade feed (as control feed) with different nutritional compositions. The data of proximate compositions of the formulated feeds used in the study showed that the feeds contained 23.60-25.85% crude protein, 7.10-11.50% crude lipid, 4.71-9.46% carbohydrate, 13.50-24.15% ash and 10.06-15.70% moisture (Fig. 1).

By analyzing the chemical composition of different formulated feeds used in the present study, it was observed that the proximate compositions of the experimental feeds were more or less within the acceptable ranges. Tongsiri *et al.*[19] found 9.38-12.93% moisture, 10.85-12.03% lipid, 18.81-20.71% crude protein, 8.42-11.41% ash and 40.59-46.01% carbohydrate in algae based feeds which were pretty similar to those obtained in the present study. The maximum crude protein and ash content were found in feed-3. Feed-4 had maximum lipid and carbohydrate content and feed 2 had highest moisture. Furthermore, The comparison between proximate compositions of experimental feeds with the report from other research work were shown in (Table 1).

Physico-chemical parameters of aquarium water: Physico-chemical parameters of water play an important role for the growth of fish[23]. Suitable physico-chemical parameters are prerequisites for healthy aquatic environment. So, suitable ranges of these parameters should maintained in any culture system. In the present study, the physico-chemical parameters (Fig. 2) did not show any significant difference among the feeding treatments and remained within the acceptable ranges for fish growth.

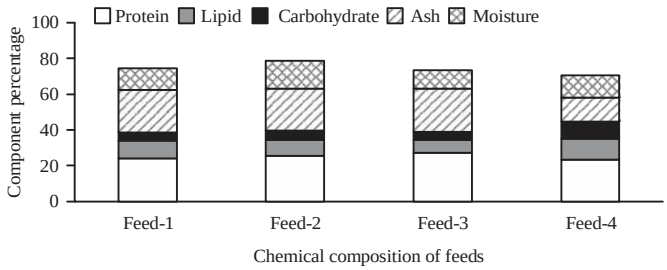

Fig. 1: Comparison of the proximate compositions of the experimental feeds

Table 1: Comparative proximate compositions of commercial feed using in other research on *Oreochromis niloticus*

Component (%)	This study (average)	Zou *et al.*[20]	Suloma *et al.*[21]	Soltan *et al.*[22]
Protein	25.240	35.42	32.00	30.18
Lipid	9.155	5.37	6.74	-
Carbohydrate	6.245	-	-	57.63
Ash	21.015	8.02	10.00	5.64
Moisture	12.715	7.20	6.00	-

The values of water temperature in four feeding treatments were found to vary from 24.52-31.79°C, which were within the acceptable range for fish growth according to Quddus and Banerjee[24], who denoted that water temperature between 24.0 and 32.0°C is suitable for fish growth. Again, Rahman *et al.*[25] reported that water temperature range, 25.5-30.0°C is favorable for fish culture. This report was accord with the present result.

The mean dissolved oxygen concentrations in four treatments were found to vary from 5.61-6.32 mg L^{-1} which were within the recommended range according to Rahman[23], who stated that DO concentration of a productive water body should be 5.0 mg L^{-1} or more. The present result was also supported by the report of Bhuiyan[26], who stated that water having DO 5.0-7.0 mg L^{-1} is fair for productivity.

The mean values of pH in four treatments varied from 7.10-7.22 (Fig. 2) which were also within the acceptable range according to Boyd[27], who reported that pH range 6.5-9.0 was suitable for fish growth. Boyd[28] reported that the pH range, 6.70-7.20 was suitable for carp fingerlings rearing. This report was also consistent with the present study. El-Sherif and El-Feky[29] reported that feed conversion ratio (FCR) increased at pH 6 and 9 of Nail tilapia but in this study FCR was high (Fig. 3) at pH 7.17 (Fig. 2).

During the study tenure, relatively lower concentrations of nutrients viz., nitrate-nitrogen, ammonium-nitrogen and phosphate-phosphorus were recorded in the water of all treatments (Fig. 2). This might be due to use of tap water which contained poor nutrients and due to regular replenishing of water from the experimental aquariums which prevent loading of nutrients from decomposition of fecal metabolizes of fish and unutilized feeds.

Growth performance and feed utilization: Feeding different types of commercially formulated feeds to fish to improve their growth rate[30]. In the present study, the growth performance of *Oreochromis niloticus* was evaluated by using different types of feed (quality feed, aftab feed, mega feed and a homemade feed as control feed). From the results (Fig. 3), it was found that the different types of commercially formulated feeds provide better growth performance comparing to the control feed (conventionally used feed).

According to the results of the study, different types of commercially formulated feed increased body weight gain in T1 (quality feed), T2 (aftab feed) and T3 (mega feed) compared to T4 (control feed). Significantly higher mean weight gain (19.06±0.89 g) was recorded in T3 (where mega feed used) over the other treatments ($p>0.05$) and the lower mean weight gain (12.10±1.12 g) was recorded in T4 (where control feed used) as well as specific growth rate (T3, 1.25±0.08%, T4, 0.89±0.11%) also (Fig. 3). In a study, Zikria *et al.*[31] found that feeding containing 26% crude protein increased body weight of *Oreochoromis niloticus*. Supporting this, the higher weight gain and specific growth rate in T3 might be due to the fish had received large amount of feed and effectively utilized the feed to convert into muscle because the maximum crude protein was 27.26% (feed-3) in here. Shoko *et al.*[32] also reported that the diet contain cotton seed cakes as a main ingredient showed significantly better growth performance of *Oreochromis niloticus*.

The results were in agreement with the findings of Dinesh *et al.*[33], who found that protein rich fish feed resulted in significantly superior weight gain and specific growth rate of rohu. The finding of Roy *et al.*[34] was also supportive to the present results. Moreover, better growth performance in T3

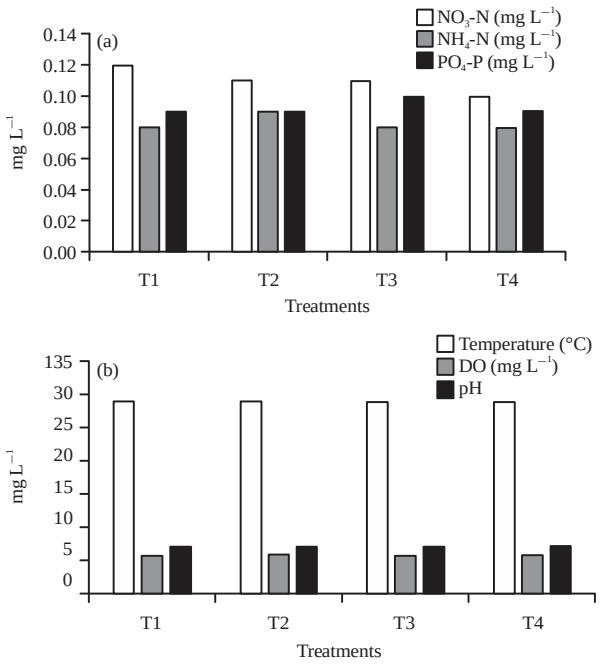

Fig. 2(a-b): Comparisons of (a) Physical and (b) Chemical parameters of water in the experimental aquariums under four treatments

Table 2: Comparative growth performance of *Oreochromis niloticus* using commercial feed from other research (with±SD, standard deviation)

Parameters	This study (average)	Zou *et al.*[20]	Suloma *et al.*[21]	Soltan *et al.*[22]
Mean initial weight (g)	6.05	3.34±0.01	24.78	1.60
Mean final weight (g)	21.45	26.14±0.32	71.35±3.67	22.14
Mean weight gain (g)	15.40	22.80	46.57	20.54
Specific growth rate (%)	1.06	3.64±0.04	1.26±0.90	2.91
Feed intake (g/fish/day)	1.21	858.38±14.50	0.86±0.07	49.95
Feed conversion ratio	1.15	1.43±0.01	1.56±0.02	1.62

might be due to the acceptability of the feed and protein abundance. This assumption agreed with the report of Hasan and MacIntosh[35], who stated that the growth of fish varied with the acceptability of feed.

The present results corroborated with the previous findings that optimum dietary lipid level resulted in improved growth rate, feed conversion ratio and utilization of other nutrients[36]. On the other hand, dietary lipid level above the optimum could have an adverse effect on growth and feed utilization as found in common carp[35,37] and *Labeo rohita*[38]. In the present study, mega feed (feed-3) had lower lipid content (7.10%) which might be resulted into lower body lipid deposition and improve growth rate (Fig. 3) in T3 (1.25±0.09 g). Therefore, the study confirmed the fact that the high lipid containing feed (Fig. 1), such as homemade feed (control feed) used in the study might have a negative effect on fish growth (0.89±0.18 g) as higher lipid content (11.5%) in feed could lead to reduce utilization of other nutrients, resulting in poor growth performance[39]. Table 2 has a glimpse of the growth performance from other research.

The present results also showed that mega feed resulted in the better FCR value (1.09) as compared to other commercially formulated feeds and control feed used (Fig. 3) in the present study. These results were partially agreement with those obtained by Zeinhom[40], who found that optimum protein and lipid in fish diets insignificantly improved the FCR value whereas feed intake was significantly increased. Dawah *et al.*[41] found that food conversion ratio was better when fishes were maintained on artificial diets with optimum nutrients components. From Suloma *et al.*[21], it seemed that FCR 1.56 has higher mean weight than others (Table 2).

Carcass compositions: This study showed that commercially formulated feeds contributed to changes in carcass protein,

Table 3: Intra and inter Pearson correlations among feeds' proximate compositions with carcass compositions in this study

	Treatments				
Feeds	Protein	Lipid	Carbohydrate	Ash	Moisture
Correlations among proximate compositions					
Protein	1				
Lipid	-0.96	1			
Carbohydrate	-0.74	0.89	1		
Ash	0.73	-0.88	-0.99	1	
Moisture	-0.27	0.21	0.08	0.005	1
Correlations among carcass compositions					
Protein	1				
Lipid	-0.29	1			
Carbohydrate	-0.34	0.58	1		
Ash	0.86	-0.22	-0.68	1	
Moisture	-0.93	0.38	0.09	-0.61	1
Correlations among proximate and carcass compositions					
Protein	0.874661	-0.004100	-0.494780	0.970332	-0.631900
Lipid	-0.936770	-0.032160	0.286046	-0.898110	0.774468
Carbohydrate	-0.887610	-0.078900	-0.111060	-0.626620	0.890114
Ash	0.852157	0.165048	0.163879	0.568110	-0.848230
Moisture	-0.483000	0.962100	0.732488	-0.474300	0.487990

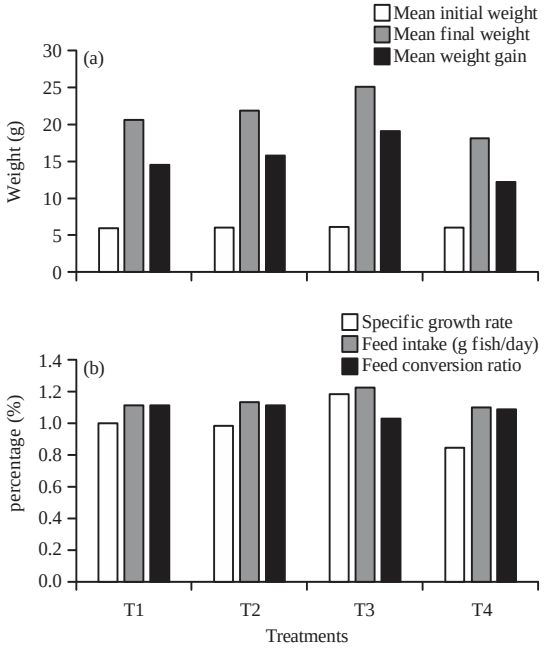

Fig. 3(a-b): Comparisons of (a) Weight gain and (b) Growth performances of the fish under different treatments

lipid, carbohydrate/glycogen, ash and moisture content of monosex tilapia. Components were closely ranged among all treatments but significantly different among each other (Fig. 5).

Malik *et al.*[42] revealed that protein utilization of *Oreochromis niloticus* were influenced by dietary protein content. In present study, the significantly higher carcass protein was recorded in T3 (19.34%) followed by T1 (18.30%) and T2 (18.12%) whereas the lower in T4 (17.12%). The higher carcass protein content (Fig. 5) of the fish from experimental feeding group treated with mega feed might have contributed by the optimum protein content (27.26%).

Ahmad *et al.*[43], Tidwell *et al.*[44] and De Pedro *et al.*[45] reported that increase in carcass protein content related with the increase in dietary protein level. Supporting this concept, the present study also showed a linear relation between them (Fig. 4). Singh *et al.*[46] revealed that protein utilization of *L. rohita* fingerlings were influenced by the dietary protein content. Rajbanshi and Mumtazuddin[47] also reported the reciprocation of dietary proteins and its utilization. Hence, the mega feed having the optimum dietary protein level (Fig. 1) might be more suitable than other feeds to provide increased carcass protein (Fig. 5).

Juan *et al.*[48] mentioned the correlation and Pearson analysis about feed formulation of grouper fish's commercial meal. Not only Pearson correlation (Table 3), this study analysis the intra and inter covariance (Table 4) and linear relations (Fig. 4) among feeds' proximate compositions with carcass compositions. Juan *et al.*[48] found a strong and positive correlation between diet crude proteins with crude ash, which is also supported by present study (Table 3). He also reported a negative Pearson value (-0.774) between diet moisture and diet crude protein, which is also similar (-0.77, Table 3) to this study.

Rubbi *et al.*[49] reported that carcass lipid content varied from 0.89-15.11% for freshwater fishes. The range of carcass lipid content of monosex tilapia varied from 2.63-2.80%. The

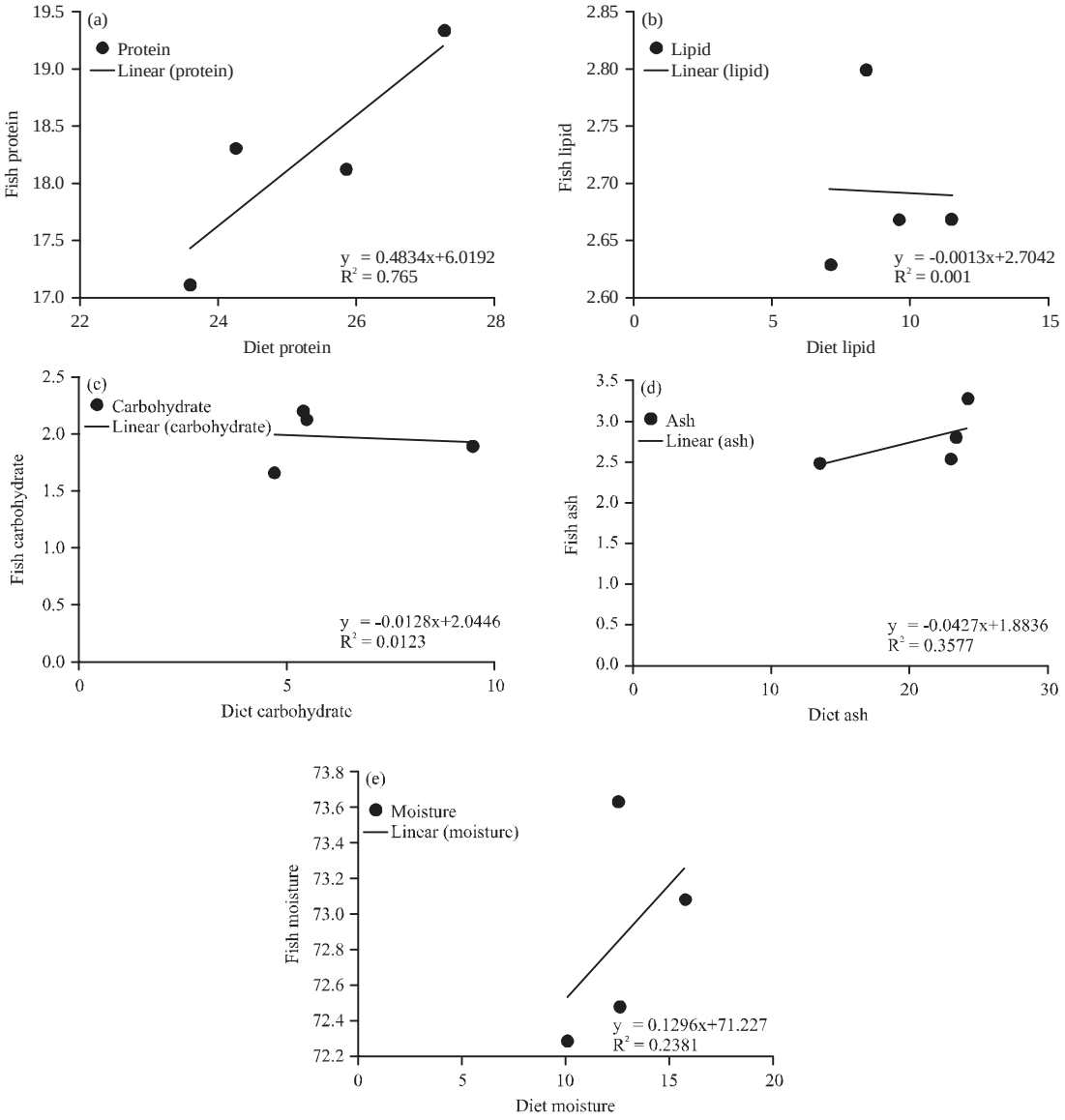

Fig. 4(a-e): Relations among feeds' proximate compositions (a) Protein, (b) Lipid, (c) Carbohydrate, (d) Ash and (e) Moisture with carcass compositions in this study

significantly highest carcass lipid content was found in treatment T2 (Fig. 5) containing aftab feed compared to other treatments containing others commercial and control feeds. There was no defined trend identified in this study. This was in contrast with the report by Ahmad *et al.*[43], who reported that carcass lipid content exhibited positive relationship with dietary lipid level in tilapia and in rainbow trout reported by Yamamoto *et al.*[50]. In case of T3 (mega feed), a non-liner relation (Fig. 4) was observed between dietary and carcass lipid content. Other research (Table 5) as well as Chen and Tsai[51], who observed either linear or inverse relationships with dietary lipid and carcass lipid. The present study showed a negative correlation (Table 3) and covariance (Table 4) of lipid with protein at all aspect during analysis, which was also supported by Juan *et al.*[48].

Ash contains many kinds of mineral that carry an important role in body structure for each organism including calcium, phosphorus, magnesium, iron, zinc and so on. It was revealed from the analysis of nutritive values of the formulated feeds that the commercially formulated feeds contained higher ash content (Fig. 1) than the control feed indicating more minerals in commercially formulated feeds, which may be liable for high deposition of nutrients in the carcass of fish. The present results showed that carcass ash content was

Table 4: Intra and inter covariance among feeds' proximate compositions with carcass compositions in this study

	Treatments				
Feeds	Protein	Lipid	Carbohydrate	Ash	Moisture
Covariance among proximate compositions					
Protein	2.03				
Lipid	-2.22	2.62			
Carbohydrate	-1.98	2.71	3.53		
Ash	4.53	-6.23	-8.16	18.99	
Moisture	-0.77	0.68	0.30	0.05	4.00
Covariance among carcass compositions					
Protein	0.62				
Lipid	-0.01	0.00			
Carbohydrate	-0.06	0.01	0.05		
Ash	0.21	0.00	-0.05	0.10	
Moisture	-0.39	0.01	0.01	-0.10	0.28
Covariance among proximate and carcass compositions					
Protein	0.98155	-0.00040	-0.15210	0.42975	-0.47850
Lipid	-1.19300	-0.00330	0.09978	-0.45140	0.66557
Carbohydrate	-1.31310	-0.00950	-0.04500	-0.36590	0.88860
Ash	2.92470	0.04616	0.15405	0.81015	-1.96450
Moisture	-0.76120	0.12356	0.31618	-0.29500	0.51897

Table 5: Comparative carcass compositions of *Oreochromis niloticus* in other research

Component (%)	This study (average)	Zou *et al.*[20]	Soltan *et al.*[22]	Olopade *et al.*[52]
Protein	18.220	15.31±0.13	62.84	13.66±2.19
Lipid	2.6925	7.63±0.31	-	-
Carbohydrate	1.965	-	-	-
Ash	2.780	3.01±0.03	10.06	1.36±0.22
Moisture	72.875	-	-	81.39±2.23

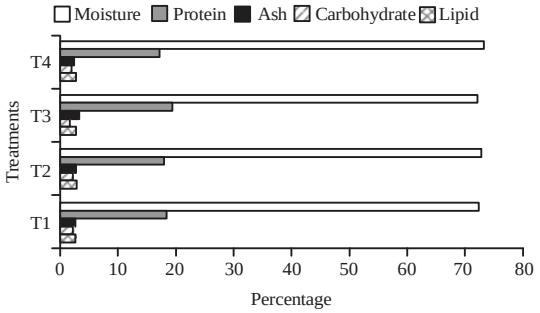

Fig. 5: Carcass composition of the fish under four treatments

comparatively higher in the fish, treated with mega feed, because fishes might be utilized the nutrients of this feed properly. This result was comparable with the report of Petenuci *et al.*[53]. Zou *et al.*[20], who got 3.64±0.04% SGR with 3.01±0.03% ash content which was higher than others (Table 5).

The similar trend, as observed in carcass lipid, was followed when the analysis was done on the basis of accumulating carcass glycogen i.e., lower glycogen content in the fish groups in T3 might be due to lower dietary carbohydrate as confirmed by the nutritive values of the feeds used. In a study, Roy *et al.*[34], observed that carcass lipid levels decreased at protein rich diet of *Oreochromis mossambicus*. These reports were supportive to the present results.

The range of carcass moisture among four treatments was 72.29-73.64%. The highest carcass moisture was found in T4 compared to other treatments. The present results were supported by Rubbi *et al.*[49], who reported that moisture content was found to vary from 72.18- 83.65%. But Olopade *et al.*[52] reported a higher moisture (81.39±2.23%) in commercial feed (Table 5) with a moderate SGR (Table 2).

CONCLUSION

After conducting 112 days trial and having a statistical comparison with other research, present study conclude that higher rate of protein with lower lipid content in feed may increase the growth of *Oreochromis niloticus*. Lower moisture and moderate carbohydrate significantly increase the feeding intake of feeds monosex tilapia also.

SIGNIFICANCE STATEMENT

The present study discovered that mega and azo feed are effective in growth raising and protein carcass because of lower content of lipid. Whereas, it also noted that feed with moderate carbohydrate and lower moisture increase the feed utility. Thus, it would help the farmers in future to find and built a good composition of feed for tilapia which may have better impact on gradual growth of this fish.

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