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Effect of Protein Rich Poultry Offal Fish Feed on growth performance of Gulsha (*Mystus cavasius*)

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Abstract

Aquaculture has emerged as a significant contributor of Bangladesh's economy, providing employment opportunities and the country's food security. Bangladesh's aquaculture industry growth relies on quality feed, improving fish health, increasing production, and profitability for farmers. The development of quality feed is crucial for the sustainable growth of the aquaculture industry in Bangladesh. Thus, the experiment was conducted to develop protein-rich poultry offal meals in the native catfish, Gulsha (*Mystus cavasius*) as fish diet. Four diets were formulated with a protein content of 35% containing various proportions of POM and fish meal. The fish meal in the basal diet of *Mystus cavasius* was replaced by 0%, 33.33%, 66.66%, and 100% POM inclusions, respectively. A total of 240 fish fingerlings (2.35 g to 2.70 g) were randomly distributed into four groups (Triplicate per group). After 60 days of feeding, the growth performance parameters of the fish were determined by required formulas and statistical tools. According to results, up to 66.66% replacement of FM with POM can be included in diets without compromising growth performance, feed utilization, and the health status of the fish. A higher substitution level of POM (100%) resulted in undesirable effects on growth performance compared with the control group. However, further research may be needed to continue into areas of utilization of POM as an alternative, least cost, and locally available protein source for replacement of FM and support sustainable aquaculture.

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Introduction

Gulsha (*Mystus cavasius*) is a freshwater catfish in Bangladesh which is a very popular fish and has a high market price (350-400 Tk/Kg) in Bangladesh (Iqbal *et al.*, 2021). Locally, it's called Gulsha, has been attracting Bangladeshi fish farmers because of its high market value, profitable culture, and good taste. Due to the high market price and consumer demand, people are more interested in the culture of Gulsha fish extensively. Therefore, it has become necessary to provide complete and cost-effective rations for this sector.

Chaturvedi and Parihar. (2012) explained that *M. cavasius* is a carnivorous eury-omnivorous, feeding on both vegetable and animal diets where animal materials contribute a significant portion of protein. Fish weight gain is linearly proportional to feed protein content, making protein content crucial for *M. cavasius* growth and conversion. A protein-rich diet supports growth, reproduction, and overall health of the fish. Since protein is typically the most expensive element of cultured fish diets, and thus dietary protein content directly affects production costs (Lazo *et al.*, 1998). According to EL Hag *et al.* (2017), fish meal (FM) is a traditional fish feed ingredient due to its high protein content, balanced amino acids, acceptability, and digestibility, making it ideal for nutrient absorption and uptake in fish. High omega-3 fatty acids in fish powder improve fish health and product quality that were derived from oily fish like anchovies, sardines, and herring. But, the steady decline in catches of wild fish, over-dependence, and increased demands for aquaculture feeds resulted in a rapid decrease in the availability of fishmeal (FAO, 2014). So, fish meal's sustainability and environmental impact are great concerns, as the fishing industry impacts on oceans and ecosystems. Finding cheaper protein sources for partial or total replacements is necessary for fish growth. According to Gatlin *et al.* (2007) who reported that replacement of fishmeal with alternative protein source to reduce reliance and high price. Islam *et al.* (2014) explained that poultry offal meal can replace fishmeal as a protein source. Poultry offal includes internal organs and edible parts of poultry, such as hearts, livers, kidneys, and feet, which were used as protein and nutrients in animal feed, and also fish feed. Hasan *et al.* (2017) found that poultry offal provides protein, vitamins, minerals for fish growth and health. Poultry offal meal is highly digestible to fish containing high nutrient composition (Bureau *et al.*, 1999). Faturoti (2000) reported that local poultry offal (cooked and dried) contained 61.6% crude protein (CP), 16.5% crude lipid, 3.5% crude fiber, 9.0% ash, and 8.3% moisture. It has been successfully used as a feed ingredient for many fish species such as grass carp (Stenopharyngodon idella), Asian seabass (Lates calcarifer), Nile tilapia (Oreochromis niloticus) etc (Tabinda and Butt, 2012; Nandakumar *et al.*, 2013; El-Sayed, 1998). Poultry offal in fish feed offers cost-effective, sustainable protein, promoting a circular economy and fish growth.

The study was carried out to formulate protein-rich poultry offal fish feed for native catfish Gulsha, evaluating growth performance and feed utilization. The results showed the potential of using poultry offal meals as a sustainable, cost-effective protein source, reducing environmental impact and making fish farming more economically viable.

Materials and methods

Study area and duration

The study was conducted at Noakhali Science and Technology University. Department of Fisheries and Marine Science laboratory during December 2022-February 2023.

Experimental fish

Gulsha (*Mystus cavasius*) fingerlings were procured from Bangladesh's Daulat fish hatchery. They were starved 24 hours, and stocked in 35-L glass aquariums for feeding trial.

Experimental diets formulation

The diets were prepared by the following steps:
Collection of ingredients;
Processing of poultry offal;
Feed formulation procedure;

Chemical composition of fish feed ingredients: Chemical composition of feedstuff were studied at DLS Animal Nutrition and Feed Section.

Formulation of experimental diets with different inclusions level of poultry offal meal: The experimental diet containing 35% protein was formulated to contain variable proportions of poultry offal meal (POM) to partially/totally replace fish meal component in the diet. The first diet (D1) containing the fish meal 30% and without the (POM), the second diet (D2) was containing 20% fish meal and 10% (POM), the third diet (D3) was containing 10% fish meal and 20% (POM), while the fourth diet (D4) containing with 30% (POM) only.

Experiment design with different feeds and treatments

The experiment was carried out using semi circulatory aquarium for 60 days in a laboratory (43 cm x 35 cm x 30 cm). The aquarium was aerated 24 hours with 25% water exchange daily, and a thermo-state water heater was fixed to maintain temperature. Four treatments were used, with identical stocking density and feed quantity. Twenty fingerlings were randomly distributed, and the aquarium was cleaned weekly. D1R1, D1R2, D1R3 for 1st treatment (control), D2R1, D2R2, D2R3 for 2nd treatment, D3R1, D3R2, D3R3 for 3rd treatment and D4R1, D4R2, D4R3 for last treatment. The experimental diet, containing 35% protein was formulated with different proportions of poultry offal meal (POM) to partially or fully replace fish meal in different treatments, and the final treatment using only 30% POM.

Feeding: Fish was fed a daily biomass diet of 12% for the first month and 10% for the second, adjusted after monthly weighing.

Feeding rate: Fish were fed 6% diets daily, divided into three halves, and adjusted at biweekly intervals based on weight increments.

Water quality monitoring: Temperature, pH, and dissolved oxygen were measured on weekly basis, daily water replacement and cleaning was also performed. Undigested food particles and wastes were removed daily, and fish survival rates were monitored.

Growth performance analysis

At the end of the experiment, fish were weighed and their total body length was also recorded individually. Survival rate (SR), specific growth rate (SGR), percent weight gain (PWG), feed conversion ratio (FCR), protein efficiency ratio (PER), condition factor (CF), were evaluated

Statistical analysis

Statistical Package for Social Sciences (SPSS) was used for analyses (analyzing growth, nutrient utilization, and biochemical composition values, and Duncan's Multiple Range Test for significant differences).

Results

Growth performance of the experimental fish

The results of the study found that processed poultry offal meal (POM) is a suitable protein source for fish feed, and can be used as a partial or complete replacement. The fish was remained healthy and active, with no harmful effects, and water quality remained consistent. Table 5 shows the growth rate, survival rate, and feed efficiency of the fish (*Mystus cavasius*) that were fed with the four experimental diets.

Survival rate

After 8 weeks of culture, the highest survival rate was observed in treatment-1, with a mean value of 94.015% and a standard deviation of 3.32.

The lowest survival rate was recorded in treatment-2, with a mean value of 89.907% and a standard deviation of 5.76. In contrast, the survival rates in treatment-3 and treatment-4 were relatively similar, with mean values of 93.106% and 93.148%, respectively, and standard deviations of 2.03 and 4.45, respectively. The survival rate was not significantly affected by treatments.

Table 1. Growth performance, survival rate and feed utilization of Gulsha (*Mystus cavasius*) fingerlings fed with four experimental diets for 60 days.

Growth Parameters	D1	D2	D3	D4
Initial weight(g)	2.355 ± 0.053	2.663 ± 0.126	2.671 ± 0.208	2.518 ± 0.13
Final weight (g)	5.553 ± 0.054	5.933 ± 0.16	6.772 ± 0.35	5.724 ± 0.11
Weight gain (g)	3.198 ± 0.042	3.335 ± 0.138	4.1 ± 0.155	3.206 ± 0.195
ADG (g/day)	0.053 ± 0.019	0.062 ± 0.002	0.068 ± 0.003	0.0534 ± 0.008
SGR (%)	1.426 ± 0.64	1.34 ± 0.72	1.55 ± 0.79	1.13 ± 0.22
PER	0.227 ± 0.047	0.21 ± 0.019	0.249 ± 0.061	0.211 ± 0.076
Condition Factor	1.142 ± 0.07	1.247 ± 0.06	1.184 ± 0.08	1.22 ± 0.11
Survival rate (%)	94.015 ± 3.32	89.907 ± 5.76	93.106 ± 2.03	93.148 ± 4.45

Notes: Values are represented as triplicate mean ± SE, with 20 fish in each replicate. Here, SE= Standard error.

Condition factor

In this study, the condition factor of fish samples in treatment-2 was high (K =1.247) and the lowest value was in treatment-1 (K=1.142) fed. Treatment-2 had a significantly higher final condition factor compared to treatment-1 and treatment-3 ($p < 0.05$). There were no significant differences between treatment-4 and any of the other treatments.

Table 2. One-way ANOVA showed the Mean weight gain (g) of fishes in four treatments.

Source	Sum of squares	Df	MS	F test	P value
Between SS	2.49	3	0.83	4.193	0.046*
Within SS	1.58	8	0.198		
Total	4.07	11			

Here, the Asterisk (*) represents the significant association ($P < 0.05$) among the four diets.

Protein Efficiency Ratio (PER)

The highest protein efficiency ratio (0.249) was observed in treatment-3, while treatment-2 had the lowest FCR value (0.21). However, treatment-1 had a PER value of (0.227), and treatment-4 had a value of (0.211). The PER values of the experimental fish in the four treatments were not significantly different. Although treatment-3 had the highest PER value, this difference was not statistically significant compared to the other treatments.

Table 3. One-way ANOVA showed the Specific Growth Rate (SGR, %) of fishes in four treatments.

Source	Sum of squares	Df	MS	F test	P value
Between SS	0.079	3	0.026	1.357	0.323 (ns)
Within SS	0.155	8	0.019		
Total	0.234	11			

Here, (ns) represents the non-significant association ($P > 0.05$) among the four diets.

Figure 4 Monthly protein efficiency ratio of fishes for different treatments.

Specific growth rate (SGR)

The SGR values were calculated based on the growth of fish during the experimental period. The mean SGR value of treatment-3 (1.55) was the highest, followed by treatment-1 (1.426), treatment-2 (1.34), and treatment-4 (1.13), respectively. The standard deviation was the highest for treatment-3, indicating that the growth rate was more variable in this group. The results suggest that treatment-3 had the highest SGR value, indicating that this treatment may have resulted in the best growth performance of the fish.

Table 4. One-way ANOVA showed the Feed Conversion Ratio (FCR, %) of fishes in four treatments.

Source	Sum of squares	Df	MS	F test	P value
Between SS	0.692	3	0.231	1.528	0.280 (ns)
Within SS	1.207	8	0.151		
Total	1.901	11			

Here, (ns) represents the non-significant association (P>0.05) among the four diets.

Average daily gain

In our study, treatment-3 had the highest average daily gain of 0.0683, while treatment-1 had the lowest average daily gain of 0.0533. Treatment-2 had an average daily gain of 0.0624, and treatment-4 had an average daily gain of 0.0534. These values indicate the mean weight gain per day of the fish in each treatment, with the standard deviation providing information about the variability of the data.

Fig. 1. Gulsha *(Mystus cavasius)*

Discussion

The study was examined to assess the impact of partial or total replacement of fish meal with poultry offal meal on Gulsha fingerlings' growth performance. The results found significant differences among different diets (treatments). Ismail *et al.* (2013) found that fishmeal can be completely replaced with poultry offal meal without adverse effects on growth performance and feed utilization. Yang *et al.* (2006) found that high-quality poultry byproduct meal (PBM) can be used without compromising growth performance, feed utilization, or fish health.

The findings of the study focused on POM as an alternative, least-cost, and locally available protein source for sustainable aquaculture. Gulsha fish is a popular, fast growing, and easily cultured species suitable for aquaculture.

The alternative protein source like poultry offal meal may reduce reliance on fish meal as the primary protein source in aquaculture diets. Water quality significantly impacts aquaculture success, promoting healthy fish growth, reducing mortality, and preventing diseases (Boyd and Tucker, 2018). Our study aimed to make water quality as comfortable as possible for fish to avoid stress.

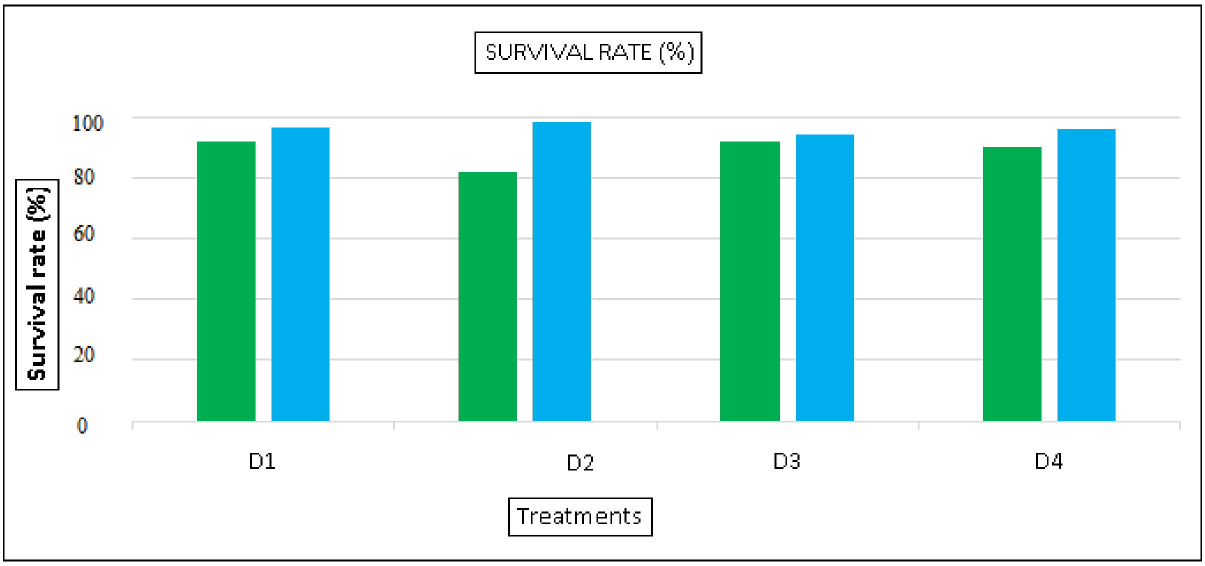

Fig. 2. Monthly survival rate of fishes during experiment.

The study found that the experimental water temperature (25.39°C) is acceptable for Gulsha farming, consistent with the previous researcher Kohinoor *et al.* (1994, 2007). Maintaining a suitable dissolve oxygen (DO) level is crucial for healthy aquatic life. Our experimental water had a satisfactory DO content for fish production, with continuous oxygen supply through an aerator. Pfeiffer & Hoehne (2019) and Timmons *et al.* (2002) also maintained the similar temperature.

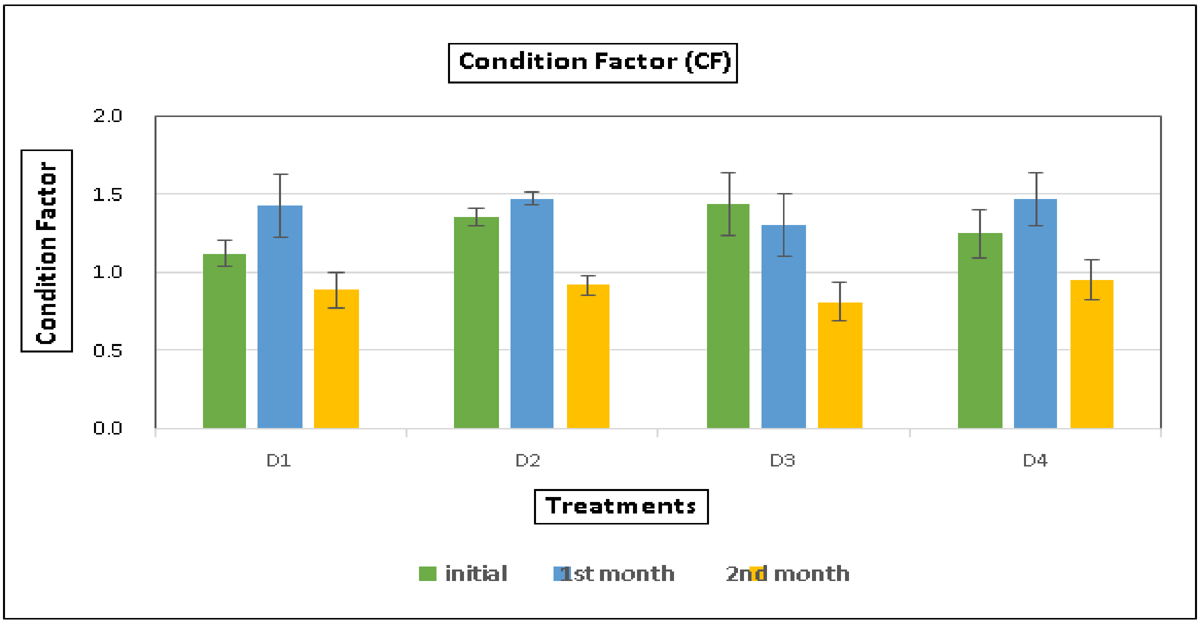

Fig. 3. Monthly condition factor of fishes during experiment.

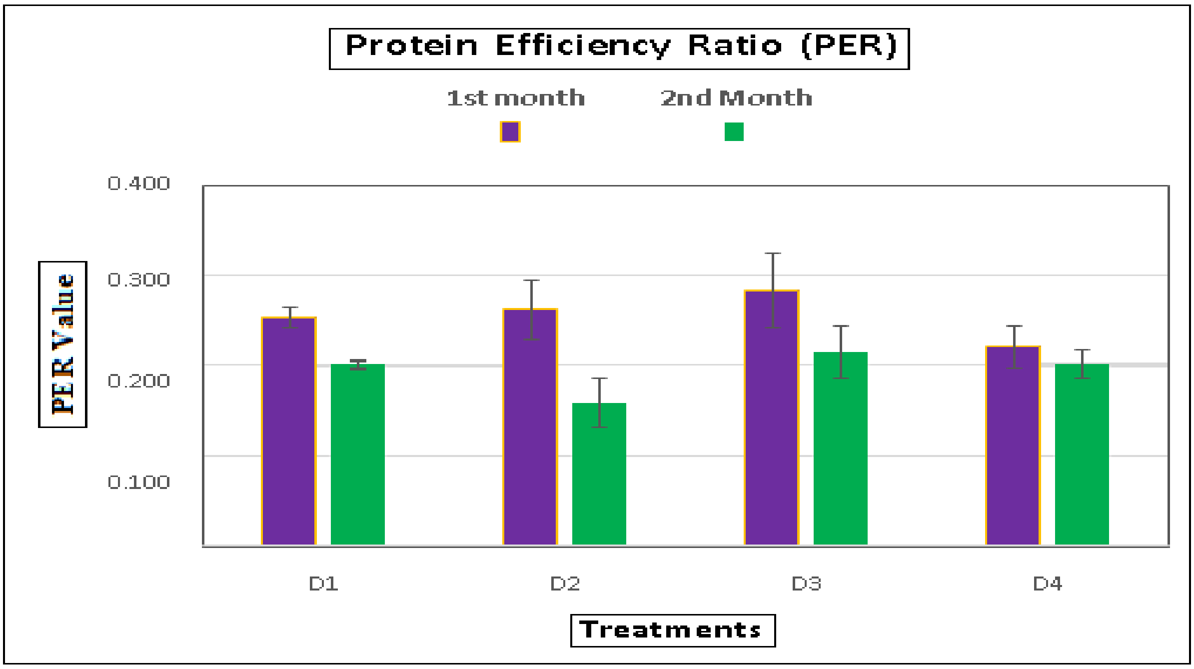

Fig. 4. Monthly protein efficiency ratio of fishes for different treatments.

Schultz and Boyd's (1999) suggested that the optimal pH for catfish fingerlings, with 7.47-8.49 suitable for fish farming. Kestemont *et al.* (2003) found the minimal pH for African catfish with range from 6.5-8.5, with levels below 6.0 or 9.0 fatal. The study revealed no significant changes in fish survival rates across treatments, but rates decreased in the first month due to low water temperatures.

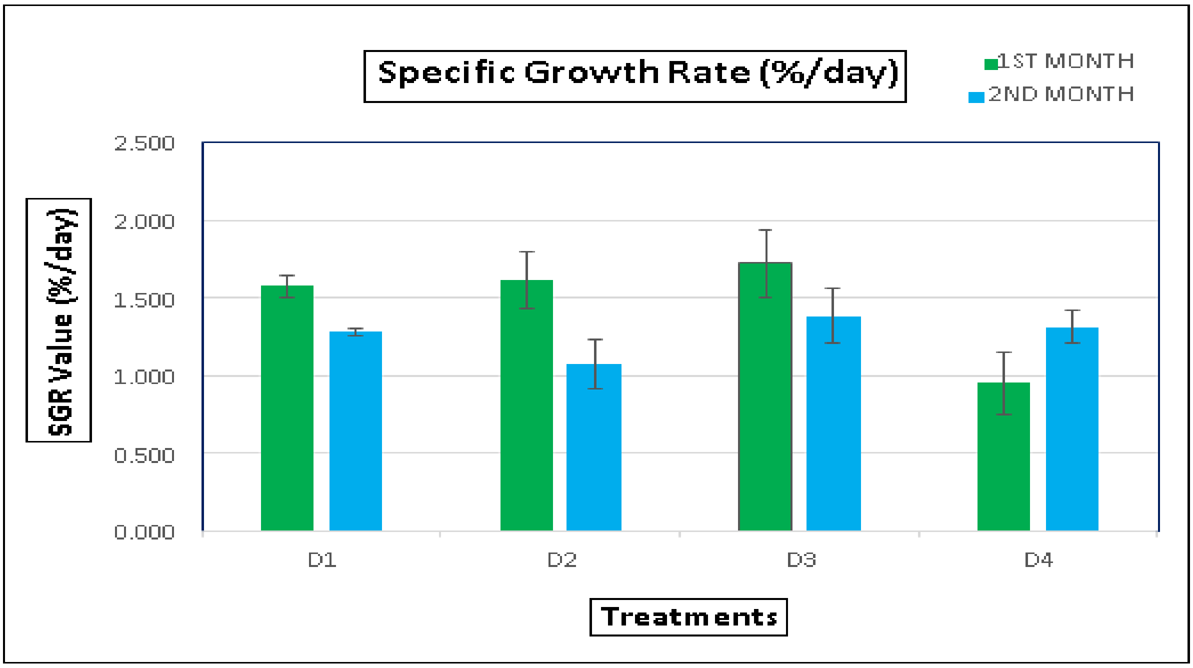

Fig. 5. Monthly specific growth rate of fishes for different treatment.

The intervention increased survival rates in all the treatments during the second month. Previous studies have shown similar survival rates. Niamat and Jafri (1984) reported 95-97% survival rates for shingi catfish. The specific growth rate (SGR) of catfish varies with the following factors like species, environment, and feed. Among the comparing four types of feed, Diet-3 had the highest SGR value, followed by Diet-1 Diet-2, and Diet-4, respectively.

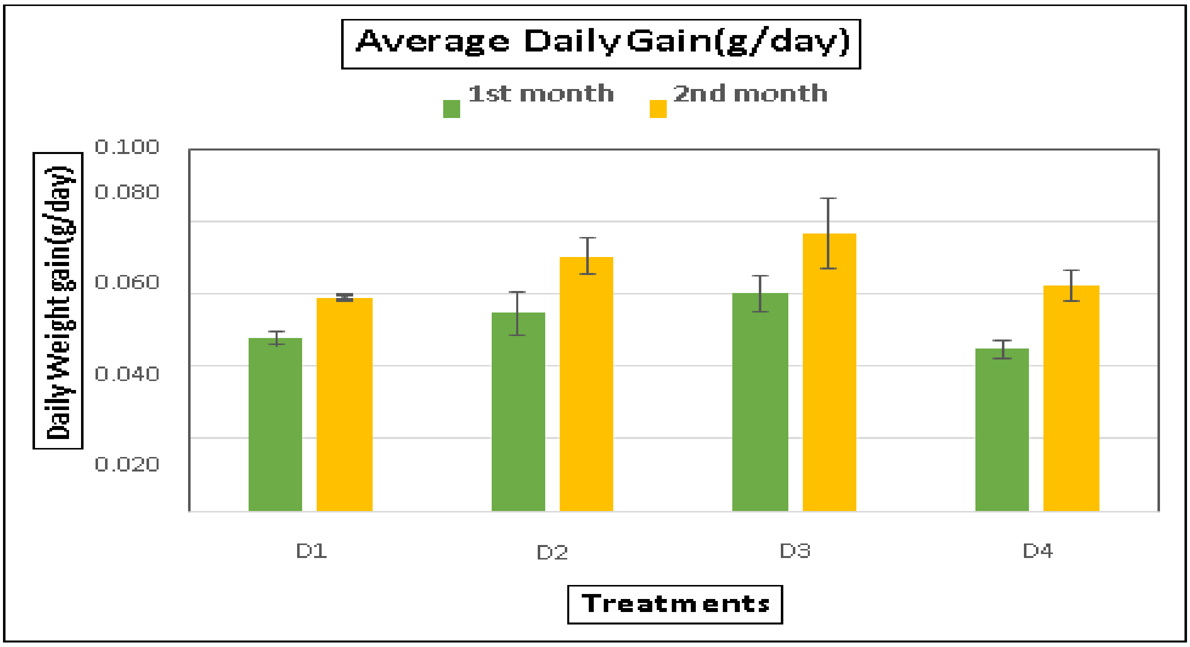

Fig. 6. Monthly average daily gain of fishes for different treatments.

This result suggests that Diet-3 may have the best growth performance, aiding in optimizing fish production and aquaculture management. Akinwole *et al.* (2017) found a specific growth rate of 1.28% per day for African catfish, while Soltan *et al.* (2020) found a growth rate of 0.85% per day for channel catfish in a recirculating aquaculture system. Condition factor (CF) is a crucial index in fishery biology to evaluate the health and well-being of fish populations (Le Cren, 1951). Diet-2 had the highest CF, while Diet-1 had the lowest. Studies found the similar results for catfish and African catfish. K values are influenced by the following factors like age, sex, season, maturation stage, food consumption, fat reserve, and muscular development (Olufemi *et al.*, 2016). The study found a protein efficiency ratio (PER) of 0.249 in Diet-3, indicating that fish can efficiently digest and absorb nutrients in diets containing plant based protein (POM) Ismail *et al.* (2013). Previous studies have found PER values of 2.03 to 2.39 for African catfish and 2.35 for catfish fed with different plant protein sources (Falya *et al.*, 2011).

The experiment showed that fish fed with Diet-1 had lower weight gain, daily weight gain, and feed utilization efficiencies compared to those fed with Diet-3. However, fish fed with 66.67% poultry offal meal showed better growth rate and feed efficiency, with a higher percentage of weight gain. The results are in a good agreement with the findings of Shapawi *et al.* (2007). The study found that poultry offal can replace up to 66.67% of fishmeal in *Mystus cavasius* diets. However, increased dietary PBM can inhibit mirror carp and Cyprinus carpio fingerling growth due to limited amino acids.

Conclusion

The results of the study explore the use of protein-rich poultry offal meals as a cost-effective alternative for Bangladesh's aquaculture industry. It shows that up to 66.66% of fish meal can be replaced with poultry offal meal without compromising growth performance, feed utilization, or health. This approach reduces environmental impact and promotes sustainable aquaculture growth. Proper processing of poultry offal meal is crucial for catfish nutrition and palatability. Conducting feeding trials and adhering to local regulations is essential for optimal catfish feed levels. Further research can be needed to evaluate the use of poultry offal in native catfish diets using different processing techniques.

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Conflicts of interest

The authors declare no conflict of interest.

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