EFFECT OF MICRONUTRIENT COMPOSITION OF FISH FEED TO THE GROWTH AND NUTRIENT CONTENT OF FISHES: COST-EFFICIENT PRODUCTION OF NUTRITIOUS FISHES

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ABSTRACT

Fish is the rich source of good quality protein. Per capita annual fish intake of Bangladesh is 21.90 kg and annual total need of fish is 42.38 lac mt. The current study's objective was to ascertain the nutritional value of various fish farmed in Bangladesh's Biofloc farm and regularly consumed by Bangladeshis by using nutrient rich formulated fish feed. The fish used in the study were tilapia fish (Oreochromis mossambicus) and shorputi fish (Systomus sarana). These fish species were cultured in a Biofloc setting. The edible portion of the samples had its composition closely investigated. The moisture, ash, and protein contents were determined using the AOAC-approved drying, Muffle-furnace, and Macro-Kjeldahl procedures, respectively. The edible proportion of fish in the current study ranged from 46.45 to 58.33%. The value for tilapia was the greatest (58.33%) while the value for shorputi was the lowest (46.45%). For some of the fish samples used in the investigation, the moisture content was found to be between 74.04 and 77.53%. Shorputi's lowest value was discovered to be 74.45%. For several fish samples, the ash concentration was determined to be between 1.04 and 1.31%. Shorputi had the greatest ash concentration (1.31%), while tilapia had the lowest (0.95%). Tilapia had a high protein content (23.77%). The study's most recent findings demonstrate that the farm formulated feed had a beneficial effect on the development and nutritional status of fish raised in biofloc systems.

KEYWORDS: Biofloc farming, Fish, Nutrient content, Aquaculture, Fish meal, Human nutrition

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Introduction

The output of domestic animal protein must grow by 250 to 300 million metric tonnes to keep up with the demand for high-quality protein by 2050, when the world's population is expected to reach 9.5 billion (1). Aquaculture has grown quickly over the past few decades, becoming a significant agricultural activity all over the world (2). Its growth and development are supported by new technology, breeding techniques, and developments in the science of animal nutrition and health. Manufacturing feeds are responsible for 50–70% of the overall operational expenses in aquaculture that is fed. Two important marine-derived components that are widely used in the aquafeed industry are fishmeal (FM) and fish oil (FO). Due to its high palatability, digestibility, balanced amino acid profile, high levels of long-chain polyunsaturated fatty acids (LC-PUFA), and phospholipids in its residual fat, FM is well known as the gold standard, nutrient-dense, and unique protein source in feed formulation for the majority of farmed aquatic species (3,4,5). Due to the loss in fishing production and the fluctuation in supply and costs, the inclusion of these ingredients in aquafeeds has decreased over time (2). The sustainability of fish stocks and aquaculture cannot be maintained in practise due to the dependence on these resources caused by the usage of these substances in the formulation of feed.

The biofloc technology (BFT) system has received attention since it is thought to be an environmentally friendly production method that can reuse water, manage nitrogen compounds, and provide high-quality food (6,7). Algae, bacteria, nematodes, protozoa, and substances like fatty acids, amino acids, isoacids, and vitamins make up Biofloc.(8) Biofloc is said to have more than 50.00% protein, 4.00% fibre, 7.00% ash, and 22.00 kJ g-1 dry matter (DM)-energy, according to the researchers.(9) Biofloc also contains volatile fatty acids, unsaturated fatty acids, and saturated fatty acids (10). Additionally, biofloc contains the vitamins niacin, riboflavin, thiamine, cobalamin, and E as well as the amino acids glutamic acid, aspartic acid, leucine, lysine, and isoleucine (11).

Approximately 63% of the animal protein in our meals comes from fisheries resources in Bangladesh, which include 260 native freshwater species, 12 foreign species, 24 freshwater prawn species, 475 marine fish species, and 36 marine prawn species (12). Bangladesh's aquaculture is expanding as a result of the rise in demand for seafood for human use and the decline in catch fisheries production. The Thai pangus has lately risen to the top of the list of the most popular economically cultivable species thanks to its high productivity and low production costs. Many hatcheries across the country are actively producing Thai pangus fry to meet farmers' demand. In Bangladesh, P. hypophthalmus pond culture has been established and is very popular. It is semi-intensive and high density. When fed protein-rich diets, this culture can produce at a pace of up to 25–30 tons per ha per year (13).

The primary requirement for fish growth, health, and reproduction is an adequate supply of nutrients, both in terms of quantity and quality. Bangladesh's aquaculture industry is expanding as a result of the increase in consumer demand for seafood and the drop in production from catch fisheries. Farmers continue to use farm-made feeds as they gradually go from no feed to factory-made feeds. Fish growth and feed utilisation are influenced by the nutritional balance of the diet. For a fish species to thrive at its best and to create a balanced diet, it is crucial to understand the nutritional requirements, especially for protein, fat, and energy. It is widely known that fish development and body composition are influenced by dietary protein and calorie consumption. Fish production costs rise and water quality deteriorates due to inadequate protein and energy levels in feed. Because a higher proportion of dietary protein is needed for energy in diets with insufficient energy, protein waste results. Additionally, the ammonia that is created might degrade the quality of the water. Contrarily, a diet heavy in energy might cause increased body fat deposition and development retardation because it lacks nutrients that promote growth (14).

Stocking a pond with two or more complimentary fish species can improve its maximum standing crop because they can utilise the full pond's volume and a wide range of food sources (15). Thus, the productivity of the aquatic system is increased by more effectively utilising natural resources already present in the environment. However, in a commercial polyculture system, just natural food cannot support high productivity, and multiple studies have shown that additional feed results in significantly faster growth rates and higher yields (16,17). The majority of pangus farmers in Thailand use various supplemental feeds. It is essential to have reliable information on these additional nutrients in order for the Thai pangus to grow quickly in a polyculture system. it is crucial that trustworthy data on these extra feeds be available. Based on trustworthy information, selecting the right kind of feed may help to promote fish development and production, which will boost profitability. Chuapoehuk and Pothisoong (1983) found that a diet containing 25% protein was great for encouraging Thai pangus to grow the fastest. When this species was reared in cages and ponds, Mollah & Sarder (1991) found that adding feeds containing 20–30% crude protein in different combinations to the diet significantly increased the species' growth (17).

Thai pangus grew on average 52g more than when fed hand-made feed and 26g more than when fed Sunney Feed when fed the commercial, protein-rich feed (Saudi-Bangla Feed). The treatment group with the highest specific growth rate (SGR), 1.60% day-1, had the highest protein content (18). Thai pangus responded to meals with higher protein contents by growing larger. Bangladesh currently has over 25 commercial fish feed industries. Among the pioneers whose feeds are sold across the country are Aftab Bohumukhi Farm Ltd., Quality Feeds Ltd., and Saudi Bangla Fish Feed Ltd. (Pers. Comm. Iv!anager, SBFF). The crude protein content, other nutrients, and presentation of the feed all have an impact on the fish's rate of growth (19). The effects of various fish diets on the nutrient content and growth of fish have not been studied. This study aims to look into the effects of fish feed on nutrient content and fish development in the fish culture business in Bangladesh.

It is widely known that fish development and body composition are influenced by dietary protein and calorie consumption. Fish production costs rise and water quality deteriorates due to inadequate protein and energy levels in feed. Because a higher proportion of dietary protein is needed for energy in diets with insufficient energy, protein waste results. Additionally, the ammonia that is created might degrade the quality of the water. As a result of a deficit in nutrients that promote growth, on the other hand, a diet high in energy can lead to increased body fat deposition and growth retardation. (14) Prebiotics, probiotics, seaweed, mushrooms, microalgae, enzymes, organic acids, mycotoxin binders, photogenic or phytobiotic chemicals, and yeasts were among the functional feed additives that Bharathi S et al., (20) demonstrated had an impact on various fish species. Fish feed contains phytobiotic or phytogenic components, which are substances produced from plants and help fish grow and stay healthy. Antioxidant, antibacterial, anticarcinogenic, analgesic, insecticidal, antiparasitic, anticoccidial, stimulator of bile secretion and digestive enzyme activity, growth promoter, and appetite stimulator are only a few of the properties these plant components possess. Astragalus radix root, Rosemary, Potato peel, Withania somnifer-Root, and Allicin (garlic) are a few examples. The nutritional value of commercial feed on the market and their relationship to the efficient growth of various fish species were also demonstrated. Comparatively speaking, though, there weren't many studies done on how those fish feeds affected or enhanced the nutritional value and quality of fish. Therefore, more research in this area is needed.yeasts in fish species, organic acids, mycotoxin binders, photogenic or phytobiotic substances, and enzymes.

Methodology

In the current study two species of fresh water fish namely Tilapia and Shorputi were selected. 2 groups were from each species; group 1 (Sample 1) was fed regular fish meal commonly used in fish farming and group 2 (Sample 2) was fed freshly made fish meal. These fishes were cultured in a biofloc setting. The growth of the fish was monitored. In the end the nutrient content of the fish was measured in laboratory.

Fish tank preparation

PVC tarpouline fish tanks were used to cultivate the fish. After tank set up the tanks were thoroughly cleaned with bleaching powder. The water was first tested for iron concentration before pouring it in the tank. The iron concentration was <0.2 ppm. After introducing the water in the tank the aeration system was continuously kept on for minimum two days. Raw salt was added on the third day to keep the TDS within

1500—1800. The pH was maintained between 7.0-8.0 by adding $CaCO_3$ to the water. 100 gm probiotic and 500 gm molasses were added to the water to grow bacteria. Oxygen supplied for a week. After every 12 hours 10 gm $CaCO_3$ was added for every 1 litre of water. The 12 gm of probiotics were added in the evening time after another 12 hours. The water colour changed after 4 days. When the 35 cm floc appeared in 1 litre of water, it indicated the tank was proper for minnows. The minnows were introduced to the water after the 3 week.

Ways to indentify that the floc is ready;
1. The water colours changed to brownish green
2. Ammonia kit will show the presence of ammonia.
3. Minimum 35 cm floc will appear in every 1 litre of water.
4. Small aeration will appear.
5. Algea will start to grow when introduced to water.

Habituating the minnows

The minnows were sanitized with potassium permanganate ($KMnO_4$) and salt. No feed was given for 24 hours. A mixture of 10gm multivitamin, 10 gm vitamin C and 10 gm Cipro Star (Ciprofloxacin) were added to the water for 5 days. 5 ml of D4+ (Disinfectant) was added after four hours (in the evening) for three days. 40% of the tank water were drained out for 24 days after introducing the minnows in the tank. No antibiotics were not added for last 6 days. 2.5% fish feed was given to the minnows after 24 hours. A mixture of multivitamin, vitamin C and Cipro Star (Ciprofloxacin) (5 gm each), Molasses and FCO (200 ml each) were added for a week to one kg of fish feed. The amount of water was gradually increased after two weeks.

Fish feed

The fish feed used in the current study were divided into four stages, such as; Pre-starter, starter, grower and finisher (Table1). The composition of the used feed for both Shorputi and Tilapia fish is given in Table 2 and 3 respectively. These feeds were used in comparison to commercially available fish feed in market. The formulated fish feed is labelled Feed 2 and the commercial feed was labelled Feed 1.

Table 1. Fish feed for fishes at different stage

Age (days)	Type of feed	Feed (%)	Frequency of feed	Expected weight of fish (gm)
01–15	Pre-starter	5	3	6
16-30	Pre-starter	5	3	25
31-50	Starter	4	3	36
51-60	Grower	4	3	50
61-75	Grower	3	3	72
76-90	Grower	3	2	100
91-105	Finisher	2	2	120
106-120	Finisher	2	2	150

Table 2. Standard level of nutrients of fish feed (% dry weight) for Shorputi

Nutrient	Level	Pre-starter	Stater (1-2)	Starter 3	Grower	Finisher
Moisture	Max.	12	12	12	12	12
Protein	Min	32	30	28	25	24
Fat/oil	Min	8	7	7	6	5
Carbohydrate	Max	26	30	33	37	38
Fiber	Max	5	6	7	8	9
Ash	Max	18	20	21	23	24
Calcium	Max	2.2	2.1	1.9	1.9	1.8
Phosphorus	Min	0.9	0.8	0.7	0.7	0.6

Table 3. Standard level of nutrients of fish feed (% dry weight) for Tilapia

Nutrient	Level	Pre-starter	Stater (1-2)	Starter 3	Grower	Finisher
Moisture	Max.	12	12	12	12	12
Protein	Min	32	28	27	25	24
Fat/oil	Min	6	6	5	5	5
Carbohydrate	Max	28	30	32	38	40
Fiber	Max	5	7	7	8	9
Ash	Max	16	18	18	20	22
Calcium	Max	2.3	2.1	2.0	1.9	1.8
Phosphorus	Min	0.8	0.7	0.6	0.5	0.4

Sample preparation

Following collection, the samples were thoroughly cleaned with distilled water, and any unwanted contaminants were eliminated by draining the surface water. The fish's weight was noted as being collected. They were subsequently handled according to protocol. Scales and viscera were taken off and divided. The fish was then cut into fillets on both sides. The edible portions for each region of the processed fish were then separated and minced after each component had been as thoroughly deboned as feasible. For the purpose of determining moisture, five gramme samples of each section were taken in triplicate. The remaining minced samples were meticulously gathered, their moist weights were recorded, and they were then frozen and stored in airtight Ziploc bags. Raw sample nutrient analysis was completed. Part of the sample was dried in an oven at 105°c and stored in air tight Ziploc bag followed by desiccation until analysis. Heavy metal and fatty acid analysis was accomplished in dry sample.

Table 4. Methods used in nutrient content analysis

Measurement	**Method**	**Instrumentation**	**Analysis Location**
Moisture	AOAC approved drying (AOAC, 2005a)	Oven	Laboratory
Ash	AOAC, 2005c	Muffle Furnace	Laboratory
Protein	Macro-Kjeldahl method (AOAC, 2005b)	Buchi Digest System, K-437; Buchi Distillation Unit, K-350 & Buchi Scrubber, B-414	Laboratory
Lipid	Modified Folch method	Separating Funnel	Laboratory

Estimation of Nutrient content of fish

Table 5 Shows the formula used to estimate th nutrient content of the fish

Table 5. Formulas used to estimate nutrient content

Variable	Formula
Edible portion	% Edible portion $= \frac{Total\ weight\ of\ whole\ fish(g) - Total\ weight\ of\ roughage(g)}{Total\ weight\ of\ whole\ fish} \times 100$
Moisture	% of Moisture $= \frac{Initial\ weight(g) - Final\ weight(g)}{Weight\ of\ sample(g)} \times 100$
Ash	% of Ash $= \frac{Weight\ of\ ash(g)}{Weight\ of\ sample\ taken(g)} \times 100$
Protein	% of Protein $= \frac{(c-b)\times 14 \times d \times Jones\ factor}{a \times 1000} \times 100$ Where, a = weight of fresh sample (g) b = volume of NaOH required for back titration (sample) c = volume of NaOH required for back titration (blank) d = normality of NaOH for titration Jones factor = conversion factor of nitrogen to protein, 6.25 14 = atomic weight of nitrogen
Lipid	% of total lipid $= \frac{Weight\ of\ extract\ (g)}{Sample\ weight\ (g)} \times 100$
Carbohydrate	% of Total Carbohydrate = {100 – (% of moisture + % of ash + % of crude protein + % of total lipid)}
Energy	Energy per 100g of edible portion = (% of carbohydrate × 4) + (% of protein × 4) + (% of fat × 9)

Results

Table 4.1 depicts the portion of edible and non-edible portions of Tilapia and Shorputi fish. The nutrient content was measured for the edible portion of the fish. Tilapia fish's edible portion ranged between 55.79% to 58.33% and Shorputi fish's edible portion ranged between 46.45%. to 48.95%.

Table 6. Edible and non-edible portion of Tilapia and Shorputi fish

Name of fishes		Edible portion (%)	Non-edible portion (%)
Local name	**Feed**		
TILAPIA	1	58.33	41.67
	2	55.79	44.21
SHORPUTI	1	48.95	51.05
	2	46.45	53.55

Table 7 shows that Tilapia Sample 1 had more moisture (78.04%) and lipid (2.09%) than sample 2. Whereas, Sample 2 had better protein (23.07%) and energy (92.33%) content than Sample 1.

Table 7. Nutrient content of Tilapia fish (*Oreochromis mossambicus)*

Nutrients	Feed 1		Feed 2	
%	Mean (S.E)	SD	Mean (S.E)	SD
Moisture	78.04 (±0.50)	4.37	74.51 (±0.33)	2.88
Protein	17.83 (±1.40)	5.91	23.07 (±1.78)	8.58
Ash	1.04 (±0.38)	0.39	0.95 (±0.37)	0.36
Lipid	2.09 (±1.37)	2.45	1.03 (±2.38)	2.41
Carbohydrate	1.00 (±0.53)	0.53	0.44 (±1.11)	0.74
Energy	94.13 (±1.19)	11.44	98.06 (±1.56)	14.43

Values are expressed in terms of wet weight.
g% = gram per 100g edible portion.
S.E. = Standard Error
S.D = Standard Deviation

Table 8 shows that Shorputi Sample 1 had more moisture (77.04%), lipid (1.83%) and carbohydrate (1.3%) than sample 2. Whereas, Sample 2 had better protein (22.4%), ash (1.31%) and energy (97.00%) content than Sample 1.

Table 8. Nutrient content of Shorputi fish (*Systomus sarana)*

Nutrients	**Feed 1**		**Feed 2**	
%	Mean (S.E)	SD	Mean (S.E)	SD
Moisture	77.04 (±0.50)	4.37	74.51 (±0.33)	2.88
Protein	18.09 (±1.25)	5.32	22.4 (±0.37)	1.74
Ash	1.25 (±0.36)	0.4	1.31 (±0.15)	0.17
Lipid	1.83 (±2.14)	2.89	0.82 (±0.72)	0.66
Carbohydrate	1.3 (±0.46)	0.53	1.02 (±0.14)	0.13
Energy	93.76 (±0.70)	6.65	97.00 (±0.50)	4.87

Values are expressed in terms of wet weight.
g% = gram per 100g edible portion.
S.E. = Standard Error
S.D = Standard Deviation

Figure 1 depicts the growth of fishes over the time. Those fish which were fed the freshly made fish meal (Feed 2) showed slightly better growth than the commercial fish meal (Feed 1) ones.

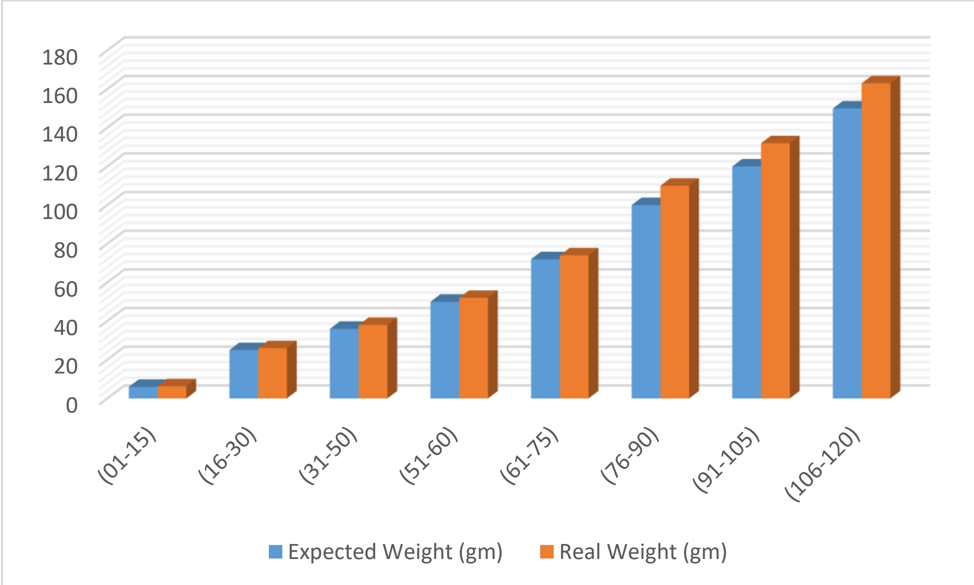

Figure 1. Growth chart of fish: The results show that the freshly made fish meal improved the growth and protein content of the fish. The combination of Biofloc culture and fish meal gave a positive result in the current study.

Discussion

In Bangladeshi custom, a substantial portion of the animal meals are made up of fish. Fish is a great source of the essential macro and micronutrients that are sorely deficient in our typical diet. The Tilapia and Shorputi fish raised in Biofloc farms are shown to have a relative composition and concentration of heavy metals in the current study. They have been given priority for investigation due to their enormous popularity among Bangladeshi citizens and the quantity of them that are consumed there. The nutrients exclusively found in the fish's edible portion were looked at in this investigation.

In the present study, tilapia fish had the highest levels of moisture and total lipid content, but shorputi fish had the highest levels of ash, protein, bioavailable carbohydrate, and calories. The range of the edible part of the chosen fish sample was determined to be between 46.45 and 58.33%. Tilapia (sample-1) had the highest value (58.33%) whereas shorputi (sample-2) had the lowest value (46.45%).

In the current investigation, the moisture content of the chosen fish was discovered to be between 74.00 and 78.00%. The tilapia (sample-1) fish had the highest value (78.04%), and the shorputi (sample-1) fish had the lowest value (77.04%). Tilapia (sample-2) and Shorputi (sample 2), fish fed feed 2, both had reduced moisture contents, at 74.51% and 74.45%, respectively.

According to a recent study, tilapia grown in the wild, ponds, ghers, and cages had moisture contents that ranged from 79.12 to 81.36% [21]. Another study [22] discovered that the moisture content of marine and freshwater fish varied from 68.34 to 81.16%. In the FCT of Bangladesh, tilapia and shorputi fish were found to have moisture contents of 76.2% and 70.6%, respectively [23]. Various factors, including the season, age, sex, and others, may affect the moisture content of fish. As a result, there is great consistency between the values reported in all of these earlier studies and the moisture content in the current study.

The current investigation found that the total ash level of the fish used for the study ranged from 0.95 to 1.31%. Shorputi in Sample-2 contains a fairly high amount of total ash (1.31%).

Tilapia reared in biofloc had an ash percentage that varied from 0.99 to 1.00%, according to a prior study [24]. Another study [21] found that the ash concentration in tilapia raised in cages, gher, ponds, and the wild varied from 0.31 to 0.53%. The FCT of Bangladesh's tilapia and shorputi fish have ash contents of 1.1% and 1.3%, respectively. Similar amounts of ash were observed in the present analysis and in the FCT of Bangladesh.

According to a recent study, fish has a protein level that ranges from 17.83 to 23.07%. Tilapia (sample-1) had the lowest percentage (17.83%), whereas sample-2 had the greatest percentage (23.07%). Tilapia has an 18.73% protein content, according to a different study on fish that are both commercially significant in freshwater and the ocean [22]. The protein values of tilapia and shorputi fish in the FCT of Bangladesh were 20.8% and 17.4%, respectively [25]. The findings of the study regarding the protein content of fish are in very good accord with the figures provided in these earlier studies.The lipid percentages of the fish employed in the current investigation ranged from 0.82 to 2.09%, it was discovered. The Shorputi value for Sample-2 was the lowest. The tilapia (sample-1) figure was the highest.

The total lipid content of tilapia ranged from 0.59 to 2.35%, according to a recent study [21]. The results of another study on the seasonal variations in the nutritional profile of fish showed that the fat level of shorputi fish during the summer was 2.50%. The new study's lipid content largely matches the range mentioned in these earlier research. The chosen fish had a carbohydrate content that ranged from 0.44 to 1.3%, according to the current analysis. The Shorputi (sample-1) sample's fish had a lot of carbohydrate. The level of carbs was found to range from 1.23 to 1.51% in a prior study [21]. We discovered a slight rise in the amount of carbohydrates, in contrast to the earlier study.

In the current experiment, it was discovered that the energy content of tilapia and shorputi fish varied from 93.76 to 97.00 Kcal/100g. Compared to other fish, shorputi (sample-2) looks to have more calories. The energy content of tilapia, which was previously believed to be between 97.62 and 126.73 Kcal/100g, was discovered to be between 94.13 and 98.06 Kcal/100g in the current study. As a result, the findings of our analysis differ slightly from those of the previous study.

According to the current analysis, not all species are equally reliable providers of all nutrients. In terms of a certain nutrient, certain fish are relatively rich and others are quite low. According to the explanation above, shorputi stands out as one of the best sources of protein.

Conclusion

In Bangladesh's fresh water fish markets, tilapia, shorputi, and other fish are available for purchase. These fish are highly high in protein and fat from a nutritional standpoint. Since these fish serve as the main source of animal protein in our diets, it is crucial to understand their unique nutrient composition in order to assess their nutritional worth. The current study demonstrates that the protein, fat, carbohydrate, and energy contents of tilapia fish and shorputi fish vary. The nutrients and growth of the biofloc fish were positively impacted by the feed's composition. As a result, this study might have a big influence on how consumers typically select fish of higher quality.

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Conflict of interest

The authors declare that they have no conflict of interest which may have inappropriately influenced them in writing this article.

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