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EFFECT OF DIFFERENT FEED REGIMES ON THE GROWTH AND SURVIAL OF NILE TILAPIA (*OREOCHOMIS NILOTICUS*) IN GLASS AQUARIUM

DILAWAR ALI[1], TOUFIQUE HASSAN[1], HAMEEDA KALHORO[1], MUHAMMAD YOUNIS LAGHARI[1], PUNHAL KHAN LASHARI*[1], WAKEELA GUL MUGHAL[2], KHALID HUSSAIN[1]

[1]Department of Fisheries and Aquatic Sciences, University of Sindh, Jamshoro-Pakistan
[2]Department of Zoology, University of Sindh, Jamshoro-Pakistan

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ABSTRACT

The present study was conducted to evaluate the growth performance of Nile Tilapia (*Oreochromis niloticus*) under different dietary treatments and their corresponding effects on water quality parameters. Three types of feed were formulated and tested: T1 (control diet), T2 (high-protein feed with 38% crude protein), and T3 (locally sourced feed with 30% crude protein). Results revealed significant differences in growth performance among treatments. The highest weight gain (19.2 g), specific growth rate (0.58%), and daily weight gain (0.2 g/day) were observed in fish fed with T2, followed by T3 (12.42 g WG and 0.53% SGR), while the lowest growth was recorded in T1 (3.0 g WG and 0.25% SGR). Survival rate was highest in T3 (100%), indicating better adaptability to local feed, whereas T1 recorded the lowest survival (50%). Water quality parameters such as temperature, pH, total dissolved solids (TDS), electrical conductivity, and salinity were monitored and found to be within acceptable limits for tilapia culture. However, T2 and T3 treatments exhibited comparatively better water quality, likely due to efficient feed utilization and reduced organic waste accumulation. The study concludes that the high-protein feed (T2) enhances growth performance significantly, while locally formulated feed (T3) offers a cost-effective alternative with satisfactory growth and optimal survival, making it suitable for sustainable tilapia aquaculture.

1. INTRODUCTION

Aquaculture is the study of rearing aquatic animals in control environment, after carp's tilapia is the second most fish is reared in all over the world, tilapia a cichlid fish belongs to Africa, tilapia is a tropical species that prefers to live in shallow water preferred temperature ranges from 31 to 36 °C. Tilapia with compressed body have cycloid scales on body (FAO 2009). Soybean and fish meal are the main components of the standard feed for tilapia (Lovell, 1988), Using feeds in aquaculture generally increase productivity. Aquaculture requires high quality feeds and high protein content. Tilapias are omnivorous fish meaning that they feed on a low trophic level (Suloma *et al*., 2015).

*Corresponding Author: lashari.punhal@usindh.edu.pk
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When tilapia is feed with proper feed they show good growth in extensive farming, they are hardy in nature and can tolerant a wide range of high-water parameters, it can live in both waters and are called euryhaline species that can tolerant a wide range of salinities. Fish feed to satiation normally exhibits the best growth and poor feed conversion ratio Also (Suloma *et al*., 2015). Algae have been used as partial or complete replacement of fishmeal in fish feed (FAO 2009). Microalgae a replacement of fishmeal is used in poly culture worldwide as a source of feed ingredient. Duckweeds are also fed as a dried meal ingredient in pelleted diets (FAO 2009)[6]. Aquatic animals cannot separate their living space from their area of excretion (Suloma *et al*., 2015). It is fast growing species that consume high amount of feed and

also excretes a large amount of feces that contaminates water, to avoid this problem fed the fish with body weight. Feeding frequency can preventing water quality deterioration as the result of excess feeding (Daudpota *et al*., 2016). Growth rate of fish directly proportional to food availability and the temperature of water, high temperature boosts the body metabolism. Feeding frequency is well known for the reduction of aquaculture production cost and preventing water quality deterioration as the result of excess feeding (Daudpota *et al*., 2016). Extension of the androgen treatment for 21-28 days enhanced the growth rate in *O.niloticus* and helped to attain faster growth rate in tilapia fry (Ajiboye *et al*., 2015). For the maximum growth of fish feeding time and feed composition is mandatory. The increasing demand of animal protein creates gap, to avoid this fish culture can fill-up this gap by using advance activities in aquaculture. Fish culture is increasing globally this can replace the other meat demand, the dietary protein is an important aspect in achieving efficient production (Abdel-Tawab and Ahmad 2009). Protein is the main compound for the growth of fish body and brain. The present study was carried out to investigate the effects of local and imported feeds on growth and survivability of Nile tilapia Aquaculture, the practice of rearing aquatic animals in a controlled environment, has gained significant attention worldwide. Tilapia, a cichlid fish native to Africa, is the second most widely farmed fish globally, after carp. This tropical species thrives in shallow waters with temperatures ranging from 31 to 36 °C (FAO 2009).

The standard feed for tilapia typically consists of soybean and fish meal (Lovell, 1988). High-quality feeds with high protein content are essential for optimal growth and productivity in aquaculture. As omnivorous fish, tilapias feed on a low trophic level, making them an attractive option for sustainable aquaculture practices (Suloma *et al*., 2015). Tilapias exhibit impressive growth rates when fed appropriately, and their hardy nature allows them to tolerate a wide range of water parameters. They are euryhaline species, capable of thriving in both fresh and brackish waters. Optimal feeding strategies, such as feeding to satiation, can lead to improved growth rates and feed conversion ratios (Suloma *et al*., 2015). Researchers have explored alternative feed ingredients, including algae, microalgae, and duckweeds, to reduce the reliance on fishmeal (FAO 2009). These innovative approaches can help mitigate the environmental impacts associated with traditional aquaculture practices.

Aquatic animals, unlike terrestrial species, cannot separate their living space from their waste excretion area. This highlights the importance of careful feeding management to prevent water quality deterioration (Suloma *et al*., 2015). Tilapias are fast-growing species that require significant amounts of feed, which can lead to substantial waste generation. To address this issue, feeding strategies based on body weight and frequency can help minimize excess feeding and maintain optimal water quality (Daudpota *et al*., 2016).

The growth rate of tilapias is directly influenced by food availability and water temperature. High temperatures can boost metabolism, while optimal feeding frequencies can reduce production costs and prevent water quality degradation (Daudpota *et al*., 2016). Research has demonstrated that extending androgen treatment for 21-28 days can enhance growth rates in Nile tilapia (Ajiboye *et al*., 2015). Furthermore, optimizing feeding times and feed composition is crucial for achieving maximum growth rates.

The increasing global demand for animal protein has created opportunities for aquaculture to fill this gap. Fish culture can provide a sustainable alternative to traditional meat sources, emphasizing the importance of dietary protein for efficient production (Abdel-Tawab and Ahmad 2009). Protein is a critical component for fish growth and development. A study investigating the effects of local and imported feeds on Nile tilapia growth and survivability highlights the significance of optimal feed composition for aquaculture success.

2. MATERIAL AND METHODS

Sample collection:

Fish were collected from fish pond at department of fisheries and aquatic Sciences University of Sindh Jamshoro by drag net and identified. Fish were shifted to a plastic drum for one day conditioning after shifted glass aquarium. Trial replicates were randomly distributed T^1, T^2 and T^3 to the three-glass aquarium and stocked with Nile tilapia collected from plastic

drum and acclimatized for two days. After acclimatization, Nile tilapia (mean initial weight, 14.6±0.01 g; and mean length 10.12±0.02 cm respectively) were reared for three months of period.

Natural feed (T^1).
In this trial T^1 were using natural diet Phyto-zooplanktons such as green micro algae species *Chlorella* and Artemia (brine shrimp), given 20 ml in twice a day. These Phyto-zooplankton were culture with the same glass aquarium.

Important feed (T^2).
Important feed purchasing market, containing 38% crude protein, 6% crude fat, 2% fiber, 2% moisture, 1% phosphorous and 7% spirulina algae and each packet in weight 1kg. The important feed made of following ingredients and quantities which showing (Table 1).

Local Ingredients Feed (T^3):
Fish feed was prepared at departmental research laboratory using local ingredients. The feed crude protein was 30% in which these ingredients were used trash fish used as fish meal a protein source in feed, wheat bran, rice bran, and mustard oil cake, and corn oil, wheat floor as a binder, table salt, vitamin and mineral capsules. An experimental feed was formulated contain 30% of protein. All ingredients were mixed together then put into the manually operated pellet machine for the preparation of pellet feed. The composition of pellet feed is shown in (Table 2).

Water parameter:
The water quality parameters such as temperature, pH, Electric conductivity, TDS, and salinity were monitored daily throughout the trial period. All water parameter were calculated by multiple electric devices such as. All studies were done in the hatchery of department fisheries and aquatic sciences, University of Sindh Jamshoro.

Growth Formulas:
Growth response and survival rate were calculated with following parameters (ANOVA)

Weight Gain = Mean final weight – Mean initial weight

Daily Weight Gain = Fresh weight gain in fish (g) / Culture period (days)

Feed Conversion Ratio (FCR) = (Wet weight gain/Dry feed intake) x 100

Specific growth rate/day (SGR)= [(Log final weight – Log initial weight) × 100] / Culture period (days)

Survival rate (SR) = (Final number of fish/Initial number of fish) x 100

Condition factor (CF) = (final weight/final lenght3) x 100.

3. RESULTS

The study showed that Tilapia fed with high-protein feed (T2-38% protein) achieved the highest growth performance, including greater weight gain (19.2 g), specific growth rate (0.58%), and daily weight gain (0.2 g/day). The locally formulated feed (T3-30% protein) resulted in moderate growth but had the highest survival rate (100%), making it a cost-effective and sustainable option. The control diet (T1) showed the lowest growth and survival (50%). Water quality was better in T2 and T3, indicating efficient feed utilization and reduced waste accumulation.

In present study our formulated feed (T2) contains 38% protein, which is a suitable level for optimal Tilapia growth. The high inclusion of premium fish meal (50%) and krill meal (25%) ensures a high-quality protein source with essential amino acids. The addition of fish oil (5%) contributes beneficial omega-3 fatty acids, enhancing fish health and growth. The presence of spirulina (2.5%) and lecithin (1%) improves pigmentation, immunity, and feed digestibility. Wheat germ, wheat flour, and soybean meal act as binding agents and provide additional energy. Vitamins and minerals (2.5%) help ensure overall health and metabolic function (Table 1).

The locally formulated feed (T3) composed of fish meal, wheat bran, rice bran, mustard oil cake, corn oil, binder, salt, and vitamin-mineral mix successfully achieved a balanced protein content of approximately 30%. Fish meal remained the primary protein source (36.5% of total feed), while wheat bran and rice bran contributed as cost-effective carbohydrate and fiber sources. The inclusion of corn oil and mustard oil cake

provided essential fatty acids and energy. This feed represents a practical and affordable alternative for tilapia farming, supporting sustainable aquaculture practices with locally available resources (Table 2).

The comparison of growth performance in Nile Tilapia under three different dietary treatments (T1: Control, T2: High-Protein Feed, T3: Local Feed) reveals the following key findings: T2 (38% Protein Feed) demonstrated the highest weight gain (19.2 g), highest daily weight gain (0.2 g/day), and specific growth rate (0.58%), indicating superior growth performance. The higher protein content and quality feed ingredients contributed significantly to better fish development. T3 (30% Protein Local Feed) showed moderate growth performance (WG: 12.42 g, SGR: 0.53%), reflecting the efficacy of locally available, cost-effective ingredients in promoting acceptable growth and high survival (100%). T1 (Control group) exhibited minimal growth performance, with the lowest WG (3.0 g), DWG (0.04 g/day), and SGR (0.25%), suggesting inadequate nutrition under baseline conditions. Feed Conversion Ratio (FCR) was best in T1 (0.89) due to lower feed intake relative to minimal weight gain, but T2's FCR (1.2) still indicates efficient feed utilization relative to its higher weight gain. Condition Factor (C.F) was highest in T2 (1.84), indicating better body condition and health. Survival Rate was highest in T3 (100%), suggesting that the locally formulated feed supported better health and environmental adaptability, while T1 had the lowest survival (50%) (Table 3).

Temperature in all treatments maintained a temperature range between 24.78°C to 25.90°C, which is within the optimal range for Nile Tilapia growth. T2 had the highest average temperature (25.9°C), which may have supported faster metabolic activity and growth. pH values remained within the suitable range for Tilapia culture (6.5-8.5). T3 exhibited the highest pH (7.36), while T2 was slightly more acidic (6.95), though still acceptable. Total Dissolved Solids (TDS), a significant difference was observed among treatments. T1 had the highest TDS (1555.16 mg/L), which may impact fish health if prolonged. T2 and T3 had significantly lower TDS levels, indicating better water quality and possibly less organic waste accumulation due to more efficient feed utilization. Electrical conductivity correlated with TDS, T1 showed the highest conductivity (3037.72 µS/cm), reflecting more dissolved ions. T2 and T3 maintained moderate conductivity, indicating better water conditions for fish. Salinity of all treatments were within acceptable freshwater salinity levels. T1 had the highest salinity (0.85 ppt), potentially contributing to stress, while T2 (0.33 ppt) and T3 (0.42 ppt) had lower and more optimal values for Nile Tilapia (Table 4).

4. DISCUSSION

The current study clearly indicates that dietary protein levels and feed composition significantly impact the growth performance and water quality management in Nile Tilapia (Oreochromis niloticus) culture systems. Among the three feed treatments, T2 (38% protein) showed the best results in terms of weight gain, specific growth rate (SGR), daily weight gain (DWG), and condition factor (C.F), confirming the well-established principle that higher protein content, especially from quality animal-based sources like fish meal and krill meal, enhances fish growth. These findings are in line with global studies such as El-Sayed (2006) and Abdel-Tawwab *et al.* (2010), which emphasized the importance of protein quality and balanced amino acid profiles in promoting optimal tilapia growth. Additionally, Ng and Hanim (2007) reported that dietary protein levels around 35-40% significantly improve feed efficiency, a result mirrored by the efficient FCR (1.2) observed in T2.

In comparison, T3 (30% protein, local feed) produced moderate but satisfactory growth and the highest survival rate (100%), highlighting its practical applicability in cost-effective aquaculture systems. This finding is supported by Musa *et al.* (2014) and Abdelghany (2003), who advocated for the use of locally available plant-based ingredients like wheat bran, rice bran, and oilseed cakes, which offer a more affordable alternative without compromising fish health or growth to a large extent.

Furthermore, T1 (control feed) exhibited the lowest performance, correlating with findings by Santiago *et al.* (1982), who emphasized the need for adequate protein levels to avoid stunted growth and higher mortality rates. The outcomes of this study are also consistent with various Pakistani studies on tilapia and fish nutrition. Shahzad *et al.* (2015) reported that

tilapia fed diets containing 35-38% protein achieved better growth and feed utilization in Punjab aquaculture systems. Their results showed similar trends in weight gain and FCR improvement, aligning with the current T2 results. Iqbal *et al.* (2017) conducted feeding trials in Sindh using indigenous plant-based feed ingredients, finding positive growth performance with 28-32% protein diets, comparable to the results from T3 in this study. Rehman *et al.* (2018) highlighted that locally prepared feed using mustard oil cake, wheat bran, and rice bran significantly reduced production costs and showed good growth potential for tilapia and carp species in semi-intensive systems. Moreover, Ali *et al.* (2020) emphasized that while high-protein commercial feeds give superior growth performance, farmer-formulated feeds from local ingredients offer sustainability, affordability, and higher survival rates, especially under small-scale farming conditions in Khyber Pakhtunkhwa and Balochistan.

The study also shows that water quality parameters were more favorable in T2 and T3 treatments, as reflected by lower TDS, salinity, and electrical conductivity. In contrast, T1 exhibited higher pollutant loads, likely due to unutilized feed and waste. This aligns with observations made by Boyd and Tucker (1998) and Naveed *et al.* (2016) in Pakistan, who linked better water quality with higher feed digestibility and growth efficiency in fish ponds and tanks.

5. CONCLUSION

The present study clearly demonstrated that the nutritional composition of feed plays a pivotal role in enhancing the growth performance, feed efficiency, survival rate, and water quality in Nile Tilapia (Oreochromis niloticus) culture systems. Among the three treatments, the high-protein feed (T2) with 38% crude protein significantly outperformed others in terms of weight gain, specific growth rate, daily weight gain, and overall body condition, highlighting the importance of a well-balanced, protein-rich diet for optimal fish growth. On the other hand, the locally formulated feed (T3) with 30% protein content showed moderate but satisfactory growth performance, coupled with the highest survival rate (100%) and better water quality parameters. This suggests that locally available, plant-based ingredients can serve as a cost-effective and sustainable alternative, especially for small-scale and rural aquaculture operations in Pakistan. The control diet (T1) showed the lowest growth and survival, underscoring the limitations of nutritionally unbalanced or conventional feeding practices still prevalent in low-input farming systems. Furthermore, the study highlighted that better feed utilization not only enhances fish growth but also contributes to improved water quality, a critical factor in maintaining healthy aquaculture environments. The results align well with both international and national (Pakistani) research, reinforcing the importance of optimizing feed formulations based on locally available resources while maintaining required protein levels. In conclusion, the study advocates for the adoption of high-protein feeds for commercial farming, while also recommending cost-effective, locally sourced feed formulations for sustainable and inclusive aquaculture development in Pakistan. This approach can significantly enhance productivity, reduce feed costs, and ensure food security, particularly in resource-limited areas.

6. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interest regarding the publication of this article.

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Table 1. Important feed with 38% protein (T^2) for *Nile Tilapia*

Ingredients	Amount
Premium Fish Meal	500g
Krill Meal	250g
Wheat Germ	50g
Molasses Yeast Powder	25g
Lecithin	10g
Soybean Meal	15g
Wheat Flower	20g
Fish Oil	50g
Spirulina	25g
Vit and Mineral	25g
Total	1000g

Table 2. Local ingredients feed with 30% protein (T^3) for Tilpia

Ingredients	Amount
Fish meal	365g
Wheat bran	290g
Rice bran	60g
Mustard oil cake	40g
Corn oil	50g
Binder	50g
Salt	3g
Vitamin and minerals	23g
Total	1000g

Table 3. Comparison of growth parameters of Nile tilapia (O. *niloticus).*

Parameters	T^1	T^2	T^3
Mean initial weight (g)	6.5	13.6	10.28
Mean final weight (g)	9.5	32.8	22.7
Mean initial length (cm)	7.4	9.52	8.7
Mean final length (cm)	8.5	12.12	11.31
Weight gain (WG)	3	19.2	12.42
Feed conversion ratio (FCR)	0.89	1.2	1.7
Daily weight gain (DWG)	0.04	0.2	0.1
Survival rate	50%	80%	100%
Condition factor (C.F)	1.54	1.84	1.56
Specific growth rate (SGR)	0.25	0.58	0.53

Table 4. Showed month-wise variation in water quality parameters in glass aquariums during the study period.

E	Temperature	pH	TDS	Electric conductivity	Salinity
T^1	25.3	7.1	457.1	835.7	0.8
T^2	25.9	6.9	455.5	853.1	0.3
T^3	24.7	7.3	481.5	894.2	0.4

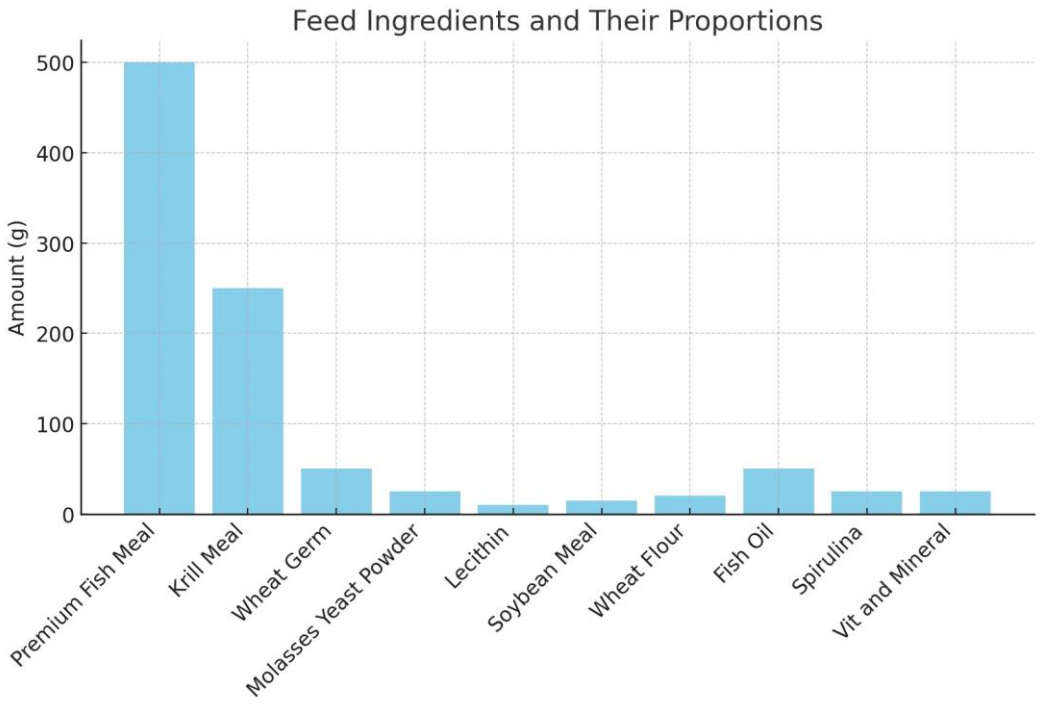

Figure 1. Graphical representations of the feed composition for Tilapia with 38% protein:

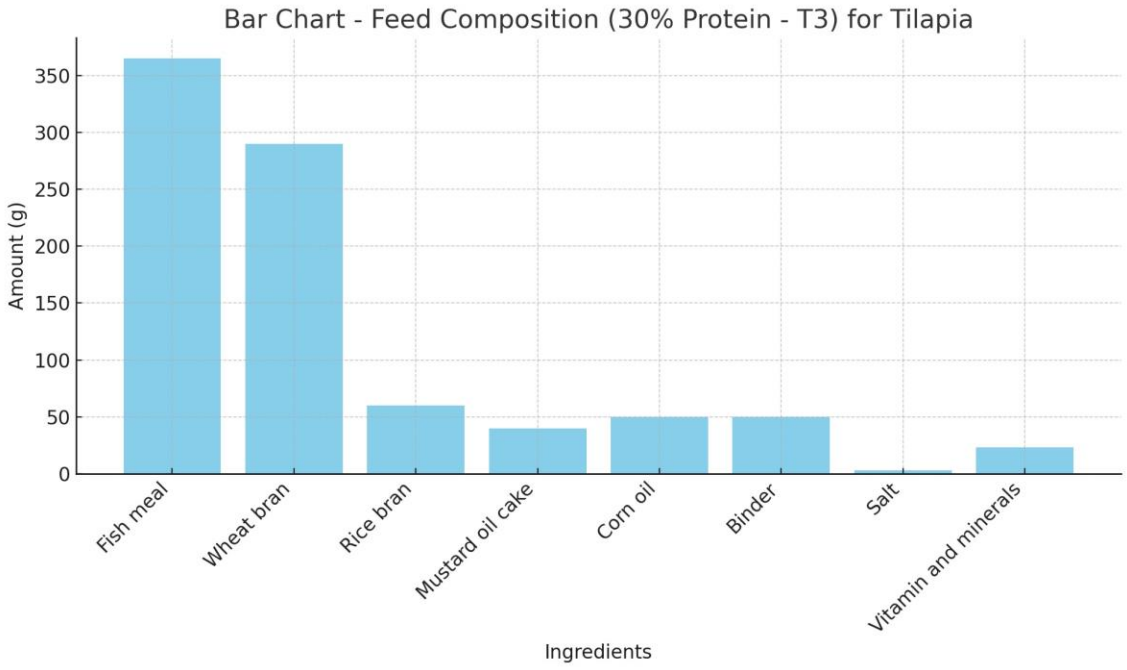

Figure 2. Visual representations of the feed composition for Tilapia using local ingredients with 30% protein (T3).

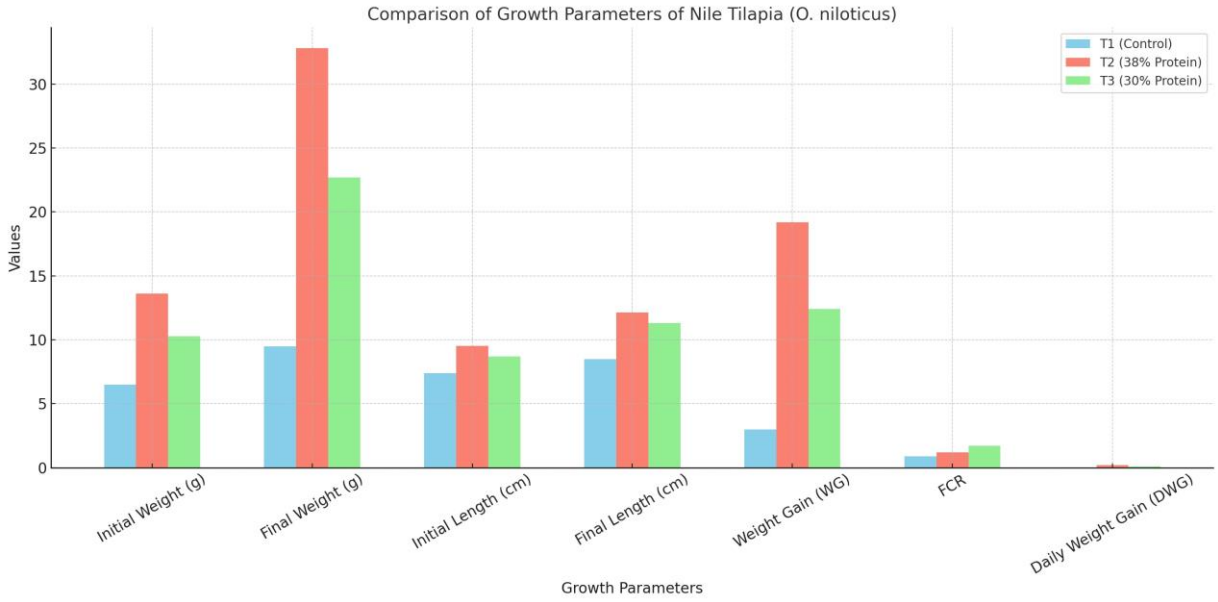

Figure 3. Graphical comparison of growth parameters of Nile Tilapia (O. niloticus) for the three different feed treatments.

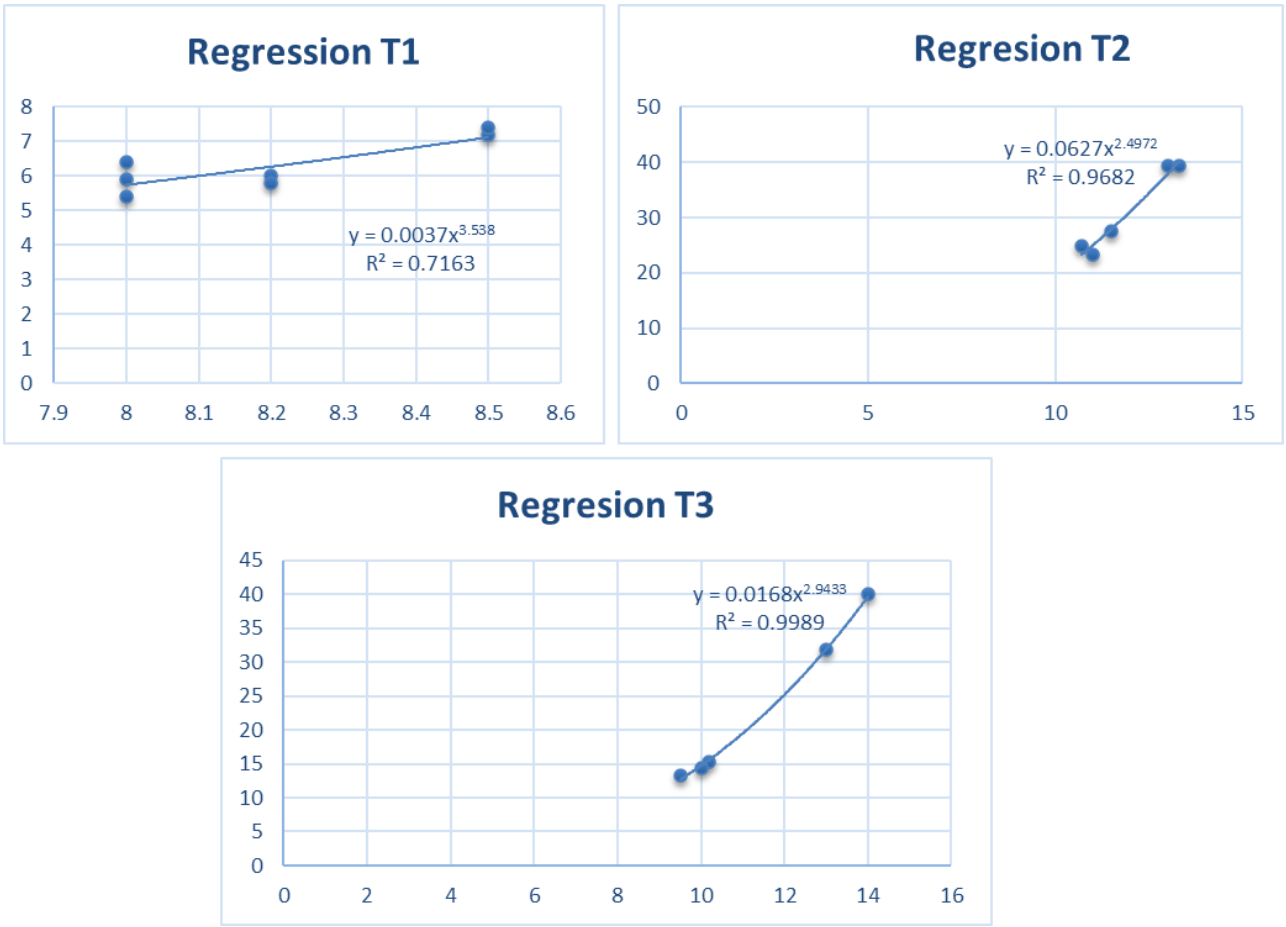

Figure. 4 Regression Analysis of fish length-weight relationship for three Treatment.

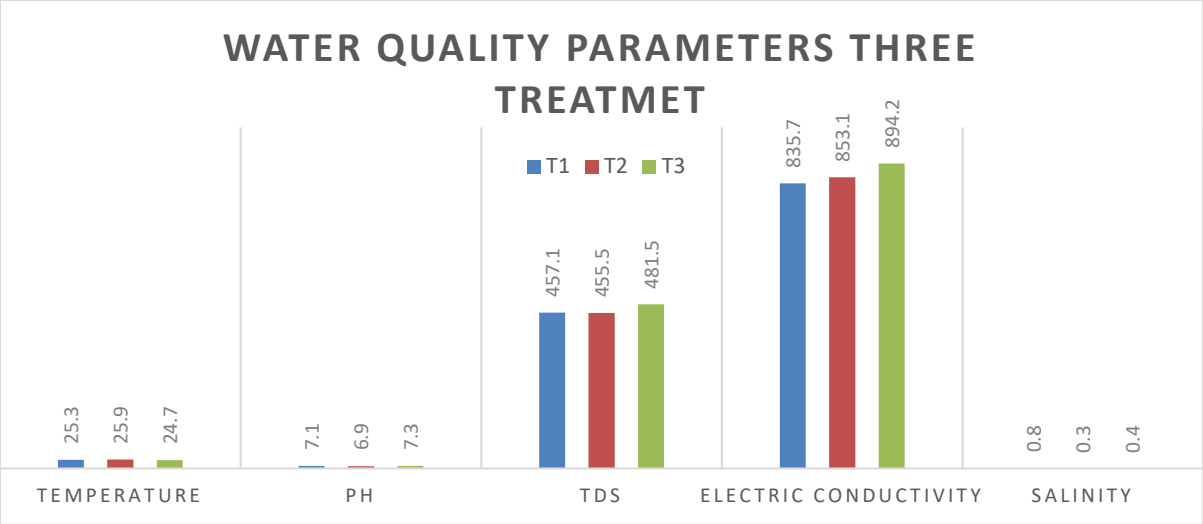

Figure 5. Bar graph showing the variation in water quality parameters across the three treatments (T1, T2, T3). Each group of bars represents a different parameter (Temperature, pH, TDS, Conductivity, and Salinity), making it easy to compare across treatments.