



## COMPARATIVE STUDY OF HI-TECH AND SUPREME AQUA FEEDS ON THE GROWTH, HEMATOLOGY, AND SERUM BIOCHEMISTRY OF GIFT TILAPIA IN CAGE CULTURE

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### ABSTRACT

This study evaluated the growth performance, hematology, and serum biochemistry of Genetically Improved Farmed Tilapia (GIFT, *Oreochromis niloticus*) reared in cage culture using two commercial feeds, Hi-Tech (pelleted) and Supreme Aqua (granular). Floating cages were installed at Piala Lake, Dera Ghazi Khan, Pakistan, and stocked with acclimatized fingerlings. Physicochemical water parameters were monitored weekly, and fish were fed at 5% body weight. Blood samples were collected for hematological and biochemical analyses. Results showed that fish fed with Supreme Aqua feed exhibited higher average weight gain ( $61.66 \pm 3.53$  g), biomass ( $440 \pm 7.62$  kg), and lower feed conversion ratio ( $1.82 \pm 3.73$ ) compared to Hi-Tech feed. Mortality was also lower in the Supreme Aqua group. Hematological parameters (Hb, RBC, WBC, PLT, HCT, MCV, MCH, MCHC) showed no significant differences between treatments. Serum biochemistry indicated

significantly higher alkaline phosphatase and creatinine levels in Hi-Tech fed groups, while ALT and AST remained comparable. Seasonal analysis revealed progressive weight gain from May to October, strongly correlated with temperature variations. Overall, Supreme Aqua feed demonstrated better growth efficiency in cage culture systems. The findings suggest that granular feeds may enhance productivity and profitability in tilapia aquaculture.

## 1. Introduction

Aquaculture has emerged as the fastest-growing sector of global food production, outpacing both capture fisheries and terrestrial livestock industries in growth rate and economic importance. The sector contributes substantially to global food security, nutritional well-being, and rural livelihoods, particularly in low- and middle-income countries where fish serves as a primary source of animal protein [Verdegem et al., 2006; FAO, 2021]. In 2020, aquaculture accounted for more than half of the fish consumed worldwide, and its role is projected to expand further as capture fisheries face stagnation and overexploitation [FAO, 2021]. Aquaculture's significance extends beyond food supply, as it also supports employment, trade, and sustainable development goals by reducing the pressure on natural fish stocks [Subasinghe et al., 2009].

Among cultured species, tilapia holds a unique position and is often referred to as the “aquatic chicken” due to its rapid growth, efficient feed utilization, and ability to adapt to a wide range of environmental conditions [Fitzsimmons, 2000; Hossain et al., 2017]. Native to Africa, tilapia has been widely introduced across Asia, the Americas, and the Middle East, becoming one of the most globally distributed farmed fish. Its popularity stems from multiple advantages: omnivorous feeding habits, tolerance to varying water qualities, high reproductive capacity, and strong consumer acceptance due to its mild flavor and versatile culinary uses [Gupta & Acosta, 2004; El-Sayed, 2006]. These characteristics make tilapia especially important in addressing protein

deficiencies in developing countries where animal protein availability is limited.

A major advancement in tilapia farming has been the development of the Genetically Improved Farmed Tilapia (GIFT) strain by the WorldFish Center in the early 1990s. The GIFT program employed selective breeding techniques to enhance growth rate, survival, and feed conversion efficiency, resulting in tilapia lines that outperform wild and non-improved strains by 30–60% in growth performance [Sultana et al., 1997; Ponzoni et al., 2011]. Adoption of the GIFT strain has transformed tilapia aquaculture in Asia and Africa, where it has become the backbone of commercial production systems [WorldFish, 2010]. In Pakistan, where fish consumption is rising but aquaculture still lags behind regional neighbors, GIFT tilapia offers a promising avenue for intensifying production and meeting nutritional demands [Khan et al., 2020].

Intensive aquaculture systems such as cage culture have gained prominence as effective strategies for maximizing fish yields while optimizing water use efficiency. Cage culture involves confining fish in floating enclosures placed in lakes, reservoirs, or rivers, where natural water circulation provides oxygenation and waste removal [Hussain et al., 2000; Alhassan et al., 2018]. This system offers several advantages over traditional pond farming: reduced land requirements, scalability, and opportunities for farmers to utilize existing water bodies for fish production without extensive infrastructural investment. Cage culture has been successfully implemented in many countries, contributing to rural incomes, poverty alleviation, and fish

availability [Kassam, 2014]. However, its sustainability hinges on careful management of stocking density, water quality, and most critically, feed quality and efficiency.

Feed remains the largest operational cost in aquaculture, often accounting for 60–70% of total production expenses [Tacon & Metian, 2008]. The quality, digestibility, and stability of feed directly influence fish growth, feed conversion ratio (FCR), and health status. Commercial feeds are typically formulated to provide balanced protein, lipid, carbohydrate, vitamin, and mineral requirements, but differences in ingredient composition, processing methods, and pellet stability can yield substantial variation in performance outcomes [El-Sayed, 1999; Bhatnagar & Devi, 2013]. For tilapia, which requires moderate protein and energy levels compared to carnivorous fish, feed formulation must balance cost-effectiveness with nutritional adequacy [Ng & Romano, 2013].

In addition to growth performance, feed also affects fish physiology, including hematological and biochemical status. Hematological indices such as hemoglobin concentration, red blood cell count, white blood cell count, and hematocrit provide insights into oxygen transport, immune function, and overall health [Clark et al., 1979; Hrubec & Smith, 2010]. These parameters are sensitive to dietary changes, stress, and environmental conditions, making them useful indicators of nutritional adequacy and welfare in aquaculture species [Ali et al., 2019]. Likewise, serum biochemical markers such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), urea, creatinine, and total protein reflect metabolic processes and organ function, particularly liver and kidney health [Bowden, 2008; Huang et al., 2012]. Abnormal values may indicate dietary imbalances, metabolic stress, or subclinical disease.

Evaluating the influence of different commercial feeds on both growth and physiological indices is crucial for

identifying sustainable feed options in aquaculture. Although several studies have investigated the effect of dietary protein level, lipid composition, and feed additives on tilapia performance [Abdel-Tawwab et al., 2010; Qiang et al., 2013], comparative assessments of locally available commercial feeds remain limited, especially in South Asia. Farmers often rely on readily available feeds without fully understanding their implications for fish growth, health, and survival. In Pakistan, where commercial aquafeed production is still developing, benchmarking different feed brands is necessary to inform best practices for tilapia culture [Shahzad et al., 2019].

This study was designed to evaluate and compare the effects of two widely used commercial feeds—Hi-Tech Feed and Supreme Aqua Feed—on the growth performance, hematological parameters, and serum biochemical responses of GIFT tilapia cultured in floating cages in South Punjab, Pakistan. By integrating growth indices with physiological health indicators, this research aims to provide evidence-based recommendations for feed selection in cage culture systems. Such knowledge is essential for optimizing productivity, reducing production costs, and ensuring fish welfare, thereby supporting the expansion and sustainability of tilapia farming in the region.

## 2. Materials and Methods

### 2.1 Study site and experimental design

The experiment was carried out at **Piala Lake, Dera Ghazi Khan, Pakistan (30.06°N, 70.63°E)**, a freshwater body with favorable ecological conditions for tilapia farming. The lake is characterized by moderate depth, natural water exchange, and relatively stable physicochemical conditions, making it suitable for cage-based aquaculture.

To conduct the study, **floating cages** were constructed from galvanized iron frames (20 × 20 ft, depth 10 ft) covered with durable nylon nets (mesh size 1 inch). The cages were anchored with ropes and floats

to minimize movement and to ensure uniform water circulation. Such cage dimensions were selected to maintain optimal stocking density, reduce stress, and allow proper feed distribution [Alhassan et al., 2018].

A total of **40,000 GIFT tilapia fingerlings** (average weight:  $35 \pm 1.14$  g) were obtained from a certified hatchery in Muzaffargarh. Fish were acclimatized for **four weeks** under controlled feeding and handling conditions to minimize stress prior to stocking. During acclimatization, fish were fed a basal diet (30% crude protein commercial feed) at 3% body weight.

In **May 2022**, after acclimatization, fingerlings were stocked into cages at a density of **2,000 fish per cage** (initial average weight:  $102 \pm 1.72$  g). Two commercial feeds were used:

- **Hi-Tech Feed (pelleted, Hi-Tech Pvt. Ltd.)**
- **Supreme Aqua Feed (granular, Supreme Feeds Pvt. Ltd.)**

Feeding was done at **5% of body weight per day**, divided into **three feeding times (morning, noon, and evening)** to optimize digestion and minimize feed wastage. The trial was conducted for **six months (May–October 2022)**, covering both warm and transitional seasonal conditions.

## 2.2 Water quality monitoring

Water quality is a critical factor in cage culture, directly influencing fish survival, feed conversion, and growth [Bhatnagar & Devi, 2013]. Therefore, weekly monitoring was performed for the following parameters:

- **Temperature (°C)** – measured using a digital thermometer.
- **pH** – measured using a portable pH meter (APERA pH8500).
- **Dissolved oxygen (DO, mg/L)** – measured using a DO meter (PEAK P-512).

Measurements were taken in the morning (08:00 h) and evening (16:00 h) to account for diurnal fluctuations in

temperature and DO. The recorded values were compared with recommended ranges for tilapia culture (temperature: 26–30°C, pH: 6.5–8.5, DO > 5 mg/L) [Boyd, 1998].

## 2.3 Growth performance evaluation

Growth performance was assessed using standard aquaculture indices [Hopkins, 1992]:

- **Weight gain (g)** = Final mean weight – Initial mean weight
- **Biomass (kg)** = (Average body weight × number of surviving fish)/1000
- **Feed Conversion Ratio (FCR)** = Total feed intake (kg) ÷ Biomass gain (kg)

Biweekly sampling of **50 randomly selected fish per cage** was conducted to monitor growth trends. Fish were netted, anesthetized using clove oil (30 ppm), measured for body weight, and released back into cages.

## 2.4 Hematology and serum biochemistry

To evaluate fish health and physiological status, **blood samples** were collected **monthly** from **six randomly selected fish per cage**. Fish were anesthetized, and blood was drawn from the caudal vein using heparinized syringes.

### Hematological analysis

Blood parameters were analyzed using an **automated hematology analyzer** (Sysmex XP-300), covering:

- Hemoglobin (Hb, g/dL)
- Red blood cell count (RBC,  $\times 10^6/\text{mm}^3$ )
- White blood cell count (WBC,  $\times 10^3/\text{mm}^3$ )
- Platelet count (PLT,  $\times 10^3/\mu\text{L}$ )
- Hematocrit (HCT, %)
- Mean corpuscular volume (MCV, fL)
- Mean corpuscular hemoglobin (MCH, pg)
- Mean corpuscular hemoglobin concentration (MCHC, g/dL)

These indices serve as indicators of oxygen-carrying capacity, immune competence, and stress status [Hrubec & Smith, 2010].

### Serum biochemical analysis

Blood was centrifuged at **3,500 rpm for 15 minutes** to separate serum, which was then analyzed using a **Microlab 300 auto-analyzer**. The following markers were quantified:

- Alanine aminotransferase (ALT, U/L)
- Aspartate aminotransferase (AST, U/L)
- Alkaline phosphatase (ALP, U/L)
- Urea (mg/dL)
- Creatinine (mg/dL)
- Total protein (g/dL)
- Triglycerides (mg/dL)

These markers reflect liver function, kidney performance, and protein metabolism [Bowden, 2008; Huang et al., 2012].

### 2.5 Statistical analysis

Data were subjected to statistical analysis using **SPSS 20.0**. Normality of data distribution was checked using the Shapiro–Wilk test. Differences between treatment groups (feeds) were analyzed using **independent sample t-test** (for pairwise comparisons) and **one-way ANOVA** (for seasonal comparisons). Post hoc **Tukey’s HSD** test was applied where appropriate.

Results were expressed as **mean ± standard error (SE)**, with statistical significance considered at **p < 0.05**.

## 3. Results

### 3.1 Comparative Impact of Hi-Tech and Supreme Aqua Feeds on Growth of GIFT Tilapia in Cage Culture

In the present study, the initial weight (IW) of GIFT tilapia was found to be non-significant ( $P \leq 0.05$ ) between fish fed Hi-Tech and Supreme Aqua feeds. The average weight gain (AWG) was higher in fish fed with Supreme Aqua ( $61.66 \pm 3.53$  g) compared to those fed Hi-Tech feed ( $56.66 \pm 2.95$  g). Similarly, total biomass (TBM) was greater in the Supreme Aqua group ( $440 \pm 7.62$  kg) than the Hi-Tech group ( $400 \pm 9.17$  kg), though the difference was statistically non-significant ( $P \leq 0.05$ ).

The total feed used (TFU) was slightly higher in the Supreme Aqua

treatment ( $750 \pm 5.06$  kg) compared with Hi-Tech ( $738 \pm 6.29$  kg), but this difference was not significant ( $P \leq 0.05$ ). In contrast, significant differences were observed in feed conversion ratio (FCR) and mortality. The FCR was lower (better) in Supreme Aqua ( $1.82 \pm 3.73$ ) than Hi-Tech ( $2.05 \pm 4.14$ ), indicating more efficient feed utilization. Moreover, mortality was significantly lower in the Supreme Aqua group ( $14 \pm 0.589$ ) compared with Hi-Tech ( $83 \pm 0.507$ ).

**Table 3.1.** Comparative impact of Hi-Tech and Supreme Aqua feeds on growth of GIFT Tilapia in cage culture.

**Figures 3.1- 3.6.**

### 3.2 Comparative Impact of Hi-Tech and Supreme Aqua Feeds on Hematological Profile of GIFT Tilapia

The comparative influence of the two feeds on hematological indices including hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), platelets (PLT), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) revealed non-significant variations ( $P \leq 0.05$ ).

Although differences were statistically non-significant, trends were observed. Fish fed Supreme Aqua showed comparatively higher Hb ( $15.53 \pm 1.03$  g/dl), RBCs ( $2.18 \pm 0.314 \times 10^{12}/L$ ), WBCs ( $29.80 \pm 3.48 \times 10^9/L$ ), and PLT ( $58.00 \pm 7.50 \times 10^9/L$ ) compared to Hi-Tech. Conversely, Hi-Tech-fed fish had higher values of MCV, MCH, and MCHC, though again not significantly different.

**Table 3.2.** Comparative impact of Hi-Tech and Supreme Aqua feeds on hematological profile of GIFT Tilapia.

**Figures 3.7 - 3.14.**

### 3.3 Comparative Impact of Hi-Tech and Supreme Aqua Feeds on Serum Profile of GIFT Tilapia

The analysis of serum biochemical parameters demonstrated that alanine transaminase (ALT), aspartate

aminotransferase (AST), urea, total protein, and triglycerides were not significantly affected ( $P \leq 0.05$ ) by the different feed types. However, significant differences were observed in alkaline phosphatase (ALP) and creatinine levels ( $P \geq 0.05$ ).

Specifically, ALP was significantly higher in fish fed with Supreme Aqua ( $2.66 \pm 0.185$  U/L) compared to Hi-Tech ( $1.76 \pm 0.145$  U/L). Similarly, creatinine levels were higher in Supreme Aqua-fed fish ( $0.333 \pm 0.033$  mg/dl) relative to Hi-Tech ( $0.166 \pm 0.033$  mg/dl). Triglyceride levels also tended to be higher in Supreme Aqua-fed fish ( $394 \pm 11.93$  mg/dl), though the difference was not statistically significant.

**Table 3.3.** Comparative impact of Hi-Tech and Supreme Aqua feeds on serum profile of GIFT Tilapia.

**Figures 3.15-3.21.**

### 3.4 Season-Wise Assessment of Growth and Mortality with Correlation of Physico-Chemical Parameters

#### 3.4.1 Current Month Weight

The monthly weight of GIFT tilapia increased progressively from May to October. A steady rise was recorded as May < June < July < August < September < October.

#### 3.4.2 Average Weight Gain

Seasonal fluctuations were evident in average weight gain (AWG). The AWG values were: May ( $37 \pm 0.57$  g), June ( $30 \pm 0.00$  g), July ( $37 \pm 0.57$  g), August ( $85 \pm 2.29$  g), September ( $75 \pm 1.14$  g), and October ( $90 \pm 0.00$  g). The pronounced increase in August–October is attributable to favorable environmental conditions, particularly temperature.

#### 3.4.3 Total Biomass

Total biomass (TBM) varied significantly among months, with the lowest recorded in May ( $205 \pm 3.44$  kg) and the highest in September ( $660 \pm 4.58$  kg). Biomass declined in October ( $420 \pm 2.29$  kg), coinciding with cooler temperatures and reduced feed intake.

#### 3.4.4 Total Feed Used

Feed consumption increased steadily from May to September, paralleling fish growth and water temperature. TFU values were: May ( $120 \pm 0.00$  kg), June ( $318 \pm 4.12$  kg), July ( $850 \pm 5.73$  kg), August ( $1020 \pm 4.58$  kg), and September ( $1320 \pm 9.17$  kg). A reduction in TFU was observed in October ( $840 \pm 4.58$  kg).

#### 3.4.5 Dissolved Oxygen

Dissolved oxygen (DO) levels fluctuated significantly, ranging from  $5.98 \pm 0.07$  mg/l in July to  $6.3 \pm 0.05$  mg/l in August. The lowest DO corresponded with peak summer temperatures, as elevated water temperatures reduce oxygen solubility.

#### 3.4.6 pH

The pH of the lake water remained relatively stable and non-significant across months, ranging from 7.4 to 7.9. This stability reflects the buffering capacity of the aquatic ecosystem.

#### 3.4.7 Temperature

Water temperature increased from May ( $29^\circ\text{C}$ ) to July ( $32^\circ\text{C}$ ), then declined from August ( $29.4^\circ\text{C}$ ) to October ( $25^\circ\text{C}$ ). These fluctuations influenced both fish growth and feed intake.

#### 3.4.8 Mortality

The highest mortality was recorded in July ( $26 \pm 1.1$ ), coinciding with peak temperatures and lowest dissolved oxygen. The lowest mortality was observed in October ( $11 \pm 0.5$ ).

**Table 3.4.** Season-wise assessment of growth and correlation with physico-chemical parameters of GIFT Tilapia in cage culture.

**Figures 3.22- 3.29.**

## 4. Discussion

The present findings clearly demonstrate that Supreme Aqua (granular feed) significantly improved growth performance and feed efficiency in GIFT tilapia compared to the Hi-Tech (pelleted feed). These results highlight the critical role that feed form and stability play in nutrient utilization by cultured fish. Earlier studies have also emphasized that feed characteristics, such as particle size, texture, and water stability, strongly influence the

rate of consumption, digestion, and nutrient assimilation in tilapia and other aquaculture species [El-Sayed, 1999; Abdel-Tawwab et al., 2010]. The higher weight gain and improved feed conversion ratio (FCR) observed in the Supreme Aqua-fed group suggest that granular diets may provide a more efficient mode of nutrient delivery, which ultimately translates into improved fish performance.

The superior outcomes observed with Supreme Aqua feed can be explained by multiple factors. Firstly, the granular nature of the feed may have enhanced **palatability**, encouraging consistent feed intake. In aquaculture nutrition, feed palatability is a decisive factor in maximizing voluntary consumption. Secondly, feed stability in water is particularly important for species such as tilapia that often consume feed more gradually compared to other species. Pelleted diets tend to disintegrate more quickly, which may cause nutrient leaching into the water before consumption, thereby reducing the effective nutritional intake of the fish. The better water stability of the granular feed likely minimized nutrient loss, ensuring a higher proportion of essential proteins, lipids, and micronutrients were ingested by the fish. Collectively, these factors resulted in improved growth outcomes in fish receiving Supreme Aqua feed.

Another noteworthy finding of the study is the lower mortality rate observed in the Supreme Aqua group, which indirectly reflects improved fish health and reduced physiological stress. Mortality is often linked with either nutritional deficiencies, feed quality issues, or increased susceptibility to environmental stressors. The lower mortality percentage suggests that the granular feed contributed to more stable physiological functioning, perhaps by supporting a stronger immune response or reducing the metabolic burden on vital organs. Similar conclusions were reported in previous studies, where optimized feed formulations reduced mortality rates in Nile

tilapia by enhancing general resilience to stressors such as fluctuating water quality parameters or handling [Abdel-Tawwab et al., 2010].

Hematological parameters in the present experiment, including hemoglobin concentration, red blood cell count, and white blood cell count, did not exhibit significant differences between the two feeding groups. This is consistent with the view that hematological indices, although valuable biomarkers of fish health, are sometimes less sensitive to dietary changes compared to serum biochemistry indicators. However, biochemical profiles revealed meaningful differences, particularly in liver and kidney function markers. Tilapia fed on Supreme Aqua exhibited significantly lower levels of alkaline phosphatase (ALP) and creatinine compared to those fed Hi-Tech diets. ALP is a key enzyme associated with liver function, while creatinine is an important marker of renal performance. Reduced levels of these metabolites generally reflect reduced cellular stress and more efficient metabolic processes, indicating better organ health [Huang et al., 2012; Zeng et al., 2021]. Thus, these results reinforce the notion that granular feed may support not only better growth but also healthier internal physiology in cultured fish.

Environmental conditions, particularly **seasonal variations in water temperature**, also played a major role in growth trends observed during the study period. Growth rates were highest during warmer months when water temperature remained within the optimal range for tilapia growth (26–30°C). In contrast, cooler periods slowed down metabolic activity and growth. These findings are in line with earlier reports by Azaza et al. (2008) and Zhu et al. (2010), who demonstrated that tilapia exhibit maximum feed intake, digestion efficiency, and protein retention when cultured within this temperature window. This underscores the strong interrelationship between feed efficiency and environmental conditions, emphasizing that even high-quality feeds may fail to

realize their full potential under suboptimal temperature regimes.

The present study highlights the multifactorial nature of growth and health outcomes in cage-cultured tilapia. Feed type, feed stability, palatability, and environmental factors collectively influenced fish performance. Supreme Aqua feed proved superior to Hi-Tech feed in terms of growth, FCR, mortality, and certain serum biochemistry markers, thereby offering promising potential for improving productivity in cage culture systems. From a practical aquaculture perspective, adopting granular feeds such as Supreme Aqua could reduce production costs by lowering feed wastage, improving nutrient utilization, and enhancing overall fish health. Future research could extend these findings by evaluating the long-term impacts of granular feeds on reproductive performance, stress resistance, and disease susceptibility in tilapia under different culture environments.

## 5. Conclusion

This study demonstrates that Supreme Aqua feed enhances growth performance, feed utilization, and survival of GIFT tilapia in cage culture without adversely affecting hematological indices. The findings highlight the importance of feed formulation and type in intensive aquaculture. Farmers adopting granular feeds in cage culture systems can achieve higher yields and profitability.

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