# Effect of Probiotic Supplementation on Growth, Biochemical Composition, and Physiological Responses of Rohu (Labeo Rohita)

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***Abstract*—This study investigates the effect of probiotic supplementation on the growth performance, biochemical composition, and physiological responses of Labeo rohita. Experimental fish were fed with probiotic-supplemented diets over a fixed period under controlled conditions. Growth parameters such as weight gain, feed conversion ratio, and specific growth rate were significantly improved in treated groups compared to control. Biochemical analysis revealed enhanced protein, lipid, and moisture content in probiotic-fed fish. Hematological and *physiological* parameters indicated better health status and stress resistance. The results suggest that probiotics play a vital role in improving nutrient utilization and metabolic efficiency. Enhanced immune response and gut health were also observed in supplemented groups. Overall, probiotic inclusion positively influenced fish performance and quality. This study highlights the potential of probiotics as a sustainable feed additive in aquaculture.**

***Index Terms*—Labeo Rohita, Probiotic Supplementary Feed, Physico-Chemical Parameters, Biochemical Composition.**

## I. INTRODUCTION

Aquaculture is a fastest growing food production sector globally (Maulu *et al.,* 2021). Probiotics is critical for improving the habitat of aquatic animals and increasing their performance while having no negative consequences for consumers. There is a lot of interest in using probiotics in fish as feed additives to improve feed values, nutrient absorption, gut microbial community, production of lactic acid, digestive enzymes and increase the available nutrients to the host (Yonar 2019; Subasinghe *et al.,* 2023; Romano 2020, and Dahiyart *et al.,* 2012).

Probiotics are live microorganisms such as bacteria, fungi and bacteria which are used as complementary feed and have beneficial effects on the host through the balance and improve the useful microbial intestine. Probiotics can increase the growth performance of the fish by producing digestive enzymes, promote their nutritional value and survival rate. The positive effects of probiotics as a feed additive on growth performance, innate immune system, intestinal microbiota, stress and disease resistance and improve the water quality have been confirmed in rainbow trout (Kumar *et al.,* 2006; Wang, 2011; Asadian *et al.,* 2015; Adel *et al.,* 2017; Mehrabi *et al.,* 2018).

Probiotics also demonstrate resilience against varying environmental conditions such as temperature fluctuations, pH changes and oxygen levels, which is essential for their stability and efficacy in aquatic systems (Fuller, 1989; Michael, 2014). Probiotics exhibit high tolerance to acidic conditions and bile salts, along with antimicrobial properties that inhibit pathogenic species, contributing to improved disease resistance in fish. Probiotics adhere well to mucosal and epithelial surfaces, possess bile salt hydrolase activity, and synthesize vitamins, riboflavin, folate and enzymes essential for fish health (Kechagia *et* *al.,* 2013; Reid, 2015; Hamad *et al.,* 2022; Fusco *et al.,* 2023). Probiotics assist the host or the environment by supporting positive effects that have been isolated from the environment. Terrestrial or aquatic organisms are the bio-friendly components of live microorganisms (He *et al.,*2017; Rohani *et al.,*2022).

Temperature affects all biological processes of aquatic species, including growth, immunity, and survival. Temperature fluctuations can negatively impact fish life cycles and aquaculture output (Mridul *et al.,* 2024). Climate change can alter local stream habitats by increasing water temperature, reducing dissolved oxygen, and decreasing stream flow (Filipe *et al.,* 2013; Portner and Peck, 2010).

Fish feed utilization efficacy is regarded as an important controlling factor of aquaculture production efficiency, resolving growth and nutrient deposition in fish carcass (Ali *et al.,* 2018; Maiti *et al.,* 2023). Feed is the most expensive component of an aquaculture enterprise, accounting for more than 40–60% of the functional variable cost, which is determined by the intensity of fish production (Jana *et al.,* 2022). It is crucial to optimize the feeding rate to satiate the energy demand concomitant with growth performance of fish (Jana *et al.,* 2021a). Fish culture cycle requires optimization of feeding practices to optimize the production of fish in a cost-effective manner (Saha *et al.,* 2021).

Among probiotic candidates, Lactobacillus acidophilus. are recognized for their ability to produce extracellular enzymes (proteases, lipases, and amylases), form resilient spores, inhibit pathogens, and colonize the intestinal mucosa. *Bacillus spp.* are isolated from soil, water, and plants, and are almost ubiquitously present in foods. (Li *et al.,* 2023). Probiotics, in the form of supplements or food products, have emerged as the most prominent ingredient in the era of functional foods. Probiotics have always been a vital component and commercial target for providing potential health benefits (Latif *et al.,* 2023; Chandrasekaran *et al.,* 2024). Probiotics offer a sustainable, health-conscious alternative to antibiotics (Hoseinifar *et al.,* 2018; Nawaz *et al.,* 2018; Gule and Geremew, 2022; Oleskin and Boyang, 2022; Mohammed *et al.,* 2025).

## II. METHODOLOGY

Experimental Fish (*Labeo Rohita)*

| | | |
|---|---|---|
| Kingdom | : | Animalia |
| Phylum | : | Chordata |
| Sub-Phylum | : | Vertebrata |
| Class | : | Actinopterygii |
| Order | : | Cypriniformes |
| Family | : | Cyprinidae |
| Genus | : | Labeo |
| Species | : | rohita |

Max. Size: 200cm TL male/unsexed; Common length: 35-45cm TL male/unsexed: Max. weight: 45kg. *Labeo rohita* (Hamilton 1822).

Preparation of the experimental Medium

Lactobacillus sporogenes was first isolated and described in 1933 by L. M. Horowitz-Wlassowa and N. W. NowotElnow and the name was accepted in the fifth edition of Bergey's manual of determinative bacteriology. However, it was transferred to Bacillus coagulans in the seventh edition of Bergey's manual due to simplification in cataloging. However, in honor of the original discoverers, the name of L. sporogeneses' was widely used, except for taxonomical purposes (www.lactospore.com). It is mentioned as a gram positive, spore forming, lactic acid producing bacillus. Clinical studies have revealed that L. sporogenes can be successfully implanted in the intestine.

Lactobacillus sporogenes spores commercially available as the pharmaceutical product SPORLAC were used for the present study. The culture and maintenance of the probiotic was done using MRS agar and nutrient broth (Titan Biotech, lndia). The SPOROLAC tablet was first opened under aseptic conditions and soaked in a physiological saline solution for overnight to get a starter culture. This step initiated the germination of the spores. Then it was inoculated in MRS broth and cultured at room temperature (32 $\pm$ 1$^{O}$C) in a rotatory shaker. From the 16 hrs culture using an inoculation loop with a streak of culture was made in MRS agar plates. After 24hrs a single colony was taken and inoculated in MRS broth to culture the probiotic bacteria in required quantity.

Procurement of Experimental Fishes

The healthy fry of Rohu was procured from Salem Mettur Dam and transported to the laboratory in oxygen filled polythene bags.

Acclimatization:

The experimental fishes are reared in plastic tubs in laboratory condition for acclimation for 5 days. During the period the acclimatization the fishes were first fed with egg yolk then slowly they were trained to feed with Tube fix

Experimental diet

Dried tube fix was collected to Edward Aquarium Shop in Salem and brought to the laboratory

Supplement feed (Probiotic milk)

Water, Sugar, Skimmed Milk Powder, Glucose, Probiotic Lactobaclisucasel strain Shirota, **Contains** Added Natural Identical Flavours. Nutritional information per serving (65ml), Energy 50kcal, Protein 0.8, Carbohydrate 11.5g, Total sugar 10.5mg. Added sugar 9.5g, Total Fat <0.1g, Cholesterol 0mg, Sodium 10.5mg. Keep Efrigerated Below 10 C.

Experimental setup

Four plastic tubs with cm diameter and (28.5) cm height was used for the present experiments. Ten Rohu fingerlings of uniform size (4.5 $\pm$7.8) were transferred to each tank. The volume of water in the experimental plastic tubs was maintained 20L. Each treatment had three replicates.

Water additive

Table 1-Dosage used in different treatment

| S. No | Treatment | Probiotic Milk |
|---|---|---|
| 1 | C | - |
| 2 | T1 | 15ml |
| 3 | T2 | 20ml |
| 4 | T3 | 30ml |

The fish were administered with different numbers of the probiotics – 6,000 NOS/ml (T1), 12,000 NOS/ml (T2), 18,000 NOS/ml (T3). The latobacilli obtained from the 16 hrs culture were washed well and required number of cells suspended in PBS were introduced in the tank water. Physiological saline was added to the control tank. The dosage of different treatment are presented in (Table 1).

Table 2- Supplementary feed

| S.NO | Treatment | Bacterial cell material |
|---|---|---|
| 1 | C | - |
| 2 | T1 | 6,000 NOS/ml |
| 3 | T2 | 12,000NOS/ml |
| 4 | T3 | 18,000 NOS/ml |

## III. MODE OF FEEDING

The experimental fish were fed on weighed quantity of Tubifex twice in a day for an hour between 9 AM to 10 AM and 4 PM to 5 PM. The unfed was collected the water content was removed carefully using a blotting paper and weighed. Immediately after feeding the food, remains in the aquarium jar were removed using a siphon with least disturbance to the fish. The water content of the unfed was removed using blotting paper and weighed. From these values, the feed consumed was calculated.

Food consumed

Food consumed = Food given - Unfed collected

FAECAL COLLECTION

Faecal matter in the experimental tanks was removed daily. The faecal were collected carefully using a siphon with least disturbance to the experimental fish. The faecal was also blotted with blotting paper and weighted dried in hot air oven at 60° C and weighed.

COMPLETION OF EXPERIMENTAL PROCESS

The food utilization experiments were continued for 28 days. Live weights of the Recurse experimental fishes were also recorded in 28th day. Based on this data, the growth and food utilization parameters were calculated.

GROWTH PARAMETERS

The growth parameters were calculated by using the following formulas.

Growth From = Final weight - initial weight

Weight gain
Growth rate = ------------------------------------------------
(mg. day $^{-1}$)
No. of days x initial weight

$$\text{Specific growth rate} = \frac{\text{Ln final weight} - \text{Ln initial weight}}{\text{No. of days}} \times 100$$

$$\text{Percentage of increase in body weight} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

FOOD UTILIZATION PARAMETERS

The scheme of food utilization is expressed with the modified formula of Petursewiez and Macfutyen (1970). The formula adopted for the present investigation was:

$$C=P+M+F$$

Where,

C = Food consumed

P = Production or Growth

M= Metabolism (Respiration or excretion)

F = Faecal output

From this relationship, the food utilization parameters were calculated as follows.

$$\text{Feeding rate} = \frac{\text{Total dry food consumed}}{\text{No. of days x Initial live weight}} \text{ (mg. g. body wt.}^{-1}\text{ day}^{-1}\text{)}$$

Food absorbed = Food consumed - faecal produced (mg. g. body wt.$^{-1}$ day$^{-1}$)

$$\text{Absorption rate} = \frac{\text{Total food absorbed (dry)}}{\text{Number of days x initial live wt. of fish}}$$

$$\text{Absorption efficiency} = \frac{\text{Food absorbed with}}{\text{Food consumed}} \times 100$$

$$\text{Gross Conversion efficiency } (K_1) = \frac{\text{Growth rate}}{\text{Feeding rate}} \times 100$$

PHYSICO–CHEMICAL PARAMETERS

The physical chemical parameters of the sample, including Oxidation- Reduction Potential (ORP), Conductivity (COND), Total Dissolved Solids (TDS), Resistance, Temperature, pH was estimated during the analysis and Dissolved Oxygen Method using by Winklers Method.

BIOCHEMICAL COMPOSITION

Estimation of Lipid: - (Phospho-vanillin method)

The lipid content of the tissue was estimated by following sulphophospho vanillian method. 100mg muscle was weighed and homogenized well in a pestle and mortar by adding 5ml of chloroform-methanol (2:1) solution. Then the sample was centrifuged at 3000 rpm for 15 minutes. Then supernatant was collected and made up to 5ml with chloroform methanol solution and then 1 ml of 0.9% NaCl was added and centrifuged for 15 minutes. Bibasic layer appeared and this layer was removed with the help of filter paper. Remaining was made up with Chloroform-methanol solution to 5 ml. From the sample, 0.5ml sample, was dried in hot- air oven then 0.5ml concentrated Sulphuric acid was added plugged with cotton and kept on the boiling water bath for 10 minutes. Then allowed to cool at room temperature and then 5ml Vanillin was added then allowed to stand for 30 minutes and read at 520 nm in spectrophotometer (Systronics, 105) Cholesterol was used as standard. Blank was prepared by using distilled water. (Barnes and Stack, 1973).

Results

Growth Parameters

Growth 28$^{th}$ day

The growth of *Labeo Rohu* treated with *L. sporogenes* was higher T3 2.2 g enhanced growth maximally. (Table 1) shows the effect of the probiotics on growth on 28$^{th}$ day of probiotics treatment. Highest body weight was recorded in T3 (55g) and least body weight was recorded in Control (35.48 g).

Growth rate

Maximum growth rate was recorded in T3 group (0.079 g/day) Minimum growth rate was observed in control (0.039 g /day).

Specific growth rate

Maximum Specific growth rate was recorded in T3(1.56 %). Minimum Specific growth rate was observed in control (1.08 %).

Percentage increase in bodyweight

Maximum % increase in body weight was recorded in T3 (55 %). Minimum % increase in body weight was observed in control (35.48 %).

Food utilization characteristics

Various food utilization parameters like feeding rate, food absorbed, absorption rate, absorption **efficiency,** gross conversion efficiency (T1) and metabolic rate are presented in (Table 2).

Food Consumed

Maximum quantity of food was consumed by T3 (12.118) and control the minimum (9.277).

Faecal output

Maximum quantity of faecal output by T2 (8.681) and T3 the minimum faecal output (6.632).

Food Absorption

Highest absorption of 5.486 g was recorded in T3. The least amount food of 0.277 g was absorbed in Control.

Feeding Rate

The feeding rate also has positive relationship with the probiotic microbial population. Least feeding rate of 0.33 mg/g/day was observed in the control. Highest feeding rate of 0.43 mg/g/day was recorded in Treatment III during the period of study (Table 2).

Absorption Rate

More absorption rate of 0.453 % was recorded in Treatment III. The least absorption rate of 0.030 % was recorded in control.

Absorption Efficiency

Least absorption efficiency of 2.99 % was observed in control. The highest absorption efficiency of 45.27 % was observed in the Treatment III.

Gross Conversion Efficiency

Least Gross conversion efficiency of 11.86 % was observed in Control. Then highest Gross conversion efficiency 18.16 % was observed recorded in Treatment III.

Physico – Chemical Parameters

The physico–chemical parameters of the water, including temperature (Figure 5), Conductivity (Figure 2), Total Dissolved Solids (Figure 3), dissolved oxygen (Figure 7), Oxidation Reduction Potential (Figure 1), Salinity (Figure 6), Resistance (Figure 4) and other relevant factors, were monitored throughout the experimental period. These parameters remained within the optimal range for the growth and survival of the organisms, ensuring that the observed physiological responses were mainly due to the probiotic supplementation rather than environmental fluctuations.

Biochemical composition

Lipid

lipid content of muscle was found to increase with increase in concentration of Lactobacillus. The maximum lipid content (2.509) was observed in Treatment III and least content of lipid (0.301) was observed at control .

## IV. DISCUSSION

The application of probiotics in aquaculture has gained considerable attention in recent years due to their ability to enhance fish growth, improve feed utilization, and maintain overall physiological health. In the present study, the probiotic bacterium Lactobacillus sporogenes was evaluated for its effect on the growth performance, food utilization efficiency, and biochemical composition of Labeo rohita fingerlings. The results obtained clearly demonstrate that probiotic supplementation significantly enhanced growth parameters, feeding efficiency, and biochemical composition compared with the control group. These findings support recent research highlighting the importance of probiotics as sustainable alternatives to antibiotics in aquaculture systems.

Growth Performance

Growth performance is one of the primary indicators used to evaluate the effectiveness of dietary supplementation in fish culture. In the present study, the growth of Labeo rohita fingerlings increased significantly with probiotic supplementation. The highest growth (2.2 g) was observed in Treatment III, whereas the control group showed the lowest growth (1.1 g). Similarly, the final weight of fish was highest in Treatment III (6.2 g) and lowest in the control group (4.2 g). The enhancement of growth performance observed in this study may be attributed to the beneficial effects of Lactobacillus sporogenes on gut microbial balance and digestive enzyme activity.

Recent studies have also reported similar results. For instance, (Dawood *et al.,* 2020) reported that probiotic supplementation significantly improved growth performance and nutrient digestibility in cultured fish species. Similarly, (Hoseinifar *et al.,* 2021) demonstrated that dietary probiotics enhance digestive enzyme activity and promote intestinal health, leading to improved growth in aquaculture species. According to Ring *et al.,*2022), probiotics contribute to improved nutrient metabolism and stimulate growth-promoting microbial populations within the fish gut.

The uniformity in initial weight among experimental groups indicates that the observed differences in growth performance were primarily due to probiotic supplementation rather than variations in the initial fish size. These findings suggest that Lactobacillus sporogenes effectively stimulates metabolic processes that promote growth in Labeo rohita fingerlings.

Growth Rate and Specific Growth Rate

Growth rate and specific growth rate are widely used indicators of fish growth efficiency. In the present study, the maximum growth rate (0.079 g/day) and specific growth rate (1.56%) were recorded in Treatment III, while the control group exhibited the lowest growth rate (0.039 g/day) and specific growth rate (1.08%).

The improvement in growth rate may be attributed to enhanced nutrient utilization resulting from probiotic supplementation. According to Abdel-Tawwab *et al.,* (2020), probiotics improve digestive efficiency by stimulating enzyme production in the gut and promoting beneficial microbial populations. This enhanced digestive capacity allows fish to utilize nutrients more efficiently, thereby accelerating growth.

Furthermore, probiotics are known to stimulate appetite and feeding behavior in fish. In the present study, the feeding rate increased from 0.33 mg/g/day in the control group to 0.43 mg/g/day in Treatment III. This indicates that probiotic supplementation may enhance feeding activity and metabolic efficiency.

Recent research by Ahmad *et al.,* (2023) demonstrated that probiotics improve gut health and increase digestive enzyme activity, which ultimately results in higher growth rates and improved feed utilization in aquaculture species. Similarly, Zhang *et al.,* (2024) reported that Lactobacillus species enhance intestinal microbial diversity and promote nutrient assimilation, thereby improving fish growth performance.

Percentage Increase in Body Weight

The percentage increase in body weight is an important parameter that reflects overall growth efficiency. In the present study, the maximum percentage increase in body weight was observed in Treatment III (55%), while the control group recorded the lowest increase (35.48%).

The significant increase in body weight may be attributed to improved digestion and nutrient absorption mediated by probiotic bacteria. Probiotics enhance intestinal morphology by increasing villi length and surface area, which facilitates greater nutrient absorption. According to El-Saadony *et al.,* (2021), probiotic supplementation improves intestinal structure and enhances nutrient absorption efficiency in fish.

Additionally, probiotics produce beneficial metabolites such as vitamins, organic acids, and antimicrobial compounds that improve fish health and metabolic efficiency. As reported by Bhatnagar and Lamba (2022), probiotic bacteria can enhance growth performance by improving nutrient assimilation and reducing the negative effects of pathogenic microorganisms.

Food Utilization Characteristics

Efficient feed utilization is essential for sustainable aquaculture production. In the present study, various food utilization parameters such as food consumption, faecal output, food absorption, feeding rate, absorption efficiency, and conversion efficiencies were analyzed to evaluate the effect of probiotic supplementation.

Food Consumption

Food consumption increased progressively with increasing probiotic supplementation. The highest quantity of food consumed was recorded in Treatment III (12.118 g), whereas the control group consumed the lowest amount (9.277 g).

The increased feed intake observed in probiotic-treated fish may be attributed to improved palatability of feed and enhanced digestive processes. According to Dawood *et al.,* (2020), probiotics stimulate digestive enzyme activity and enhance gut health, which in turn increases appetite and feeding efficiency.

Recent findings by Kumar *et al.,* (2022) also indicate that dietary probiotics stimulate feeding behavior and improve feed intake in carp species by enhancing digestive enzyme secretion.

Faecal Output

Faecal output provides an indication of feed digestibility and nutrient utilization. In the present study, variations in faecal output were observed among the experimental groups. The reduced faecal output observed in probiotic treated fish indicates improved digestion and nutrient assimilation.

Probiotics enhance digestion by producing enzymes that break down feed components into simpler molecules, thereby reducing the amount of undigested material excreted as faeces. According to Hoseinifar *et al.,* (2021), probiotic bacteria significantly improve feed digestibility and reduce waste output in aquaculture systems.

Food Absorption and Absorption Rate

Food absorption increased significantly with probiotic supplementation, reaching a maximum of 5.486 g in Treatment III compared to only 0.277 g in the control group. Similarly, the absorption rate increased from 0.030% in the control group to 0.453% in Treatment III.These results indicate that Lactobacillus sporogenes enhances nutrient absorption in Labeo rohita fingerlings. According to Ring *et al.,* (2022), probiotics improve intestinal microbial balance and enhance nutrient absorption by strengthening the intestinal mucosal barrier.

Absorption Efficiency

Absorption efficiency increased remarkably from 2.99% in the control group to 45.27% in Treatment III. This significant increase indicates that probiotic supplementation greatly enhances digestive efficiency.

Recent studies have shown that probiotics improve intestinal enzyme activity and increase nutrient transport across intestinal membranes. Ahmad *et al.,* (2023) reported that probiotic bacteria enhance intestinal enzyme secretion and nutrient uptake, thereby improving feed utilization efficiency in aquaculture species.

Conversion Efficiencies

Gross conversion efficiency increased from 11.86% in the control group to 18.16% in Treatment III. Improved feed conversion efficiency is an important factor for reducing feed costs and increasing aquaculture productivity.

According to Zhang *et al.,* (2024), probiotic supplementation significantly improves feed conversion ratio and nutrient metabolism in fish by promoting beneficial microbial populations in the digestive tract.

Physico-Chemical Parameters

Water quality parameters such as temperature, dissolved oxygen, pH, and ammonia concentration play a crucial role in fish growth and survival. Probiotic microorganisms are known to improve water quality by reducing harmful microbial populations and enhancing nutrient cycling.

According to Bhatnagar and Lamba (2022), probiotics can improve the microbial balance of aquaculture systems and reduce the accumulation of toxic metabolites such as ammonia and nitrite. This creates a more favorable environment for fish growth and survival.

Physico–chemical parameters of water play a crucial role in maintaining the health and physiological stability of aquatic organisms. Parameters such as temperature, pH, and dissolved oxygen directly influence metabolic activity, respiration, and growth.

In the present study, the physico–chemical parameters remained within the optimal range throughout the experimental period. Maintaining stable environmental conditions ensured that the observed physiological responses were primarily due to probiotic supplementation rather than environmental fluctuations.

Several studies have emphasized the importance of maintaining optimal water quality in aquaculture systems. According to Boyd (2020), stable water quality parameters are essential for maintaining metabolic balance and preventing physiological stress in aquatic organisms.

Similarly, Badiola *et al.,* (2021) reported that optimal physico–chemical conditions support efficient respiration and metabolic activity in cultured fish. When environmental parameters remain stable, dietary interventions such as probiotic supplementation can exert their full beneficial effects.

Recent research by Hoseinifar *et al.,* (2022) also highlighted that probiotics can indirectly improve water quality by enhancing microbial balance in aquaculture systems. This can further support the health and physiological stability of cultured organisms.

Therefore, the stable physico–chemical conditions maintained during the present study ensured that the improvements observed in respiratory physiology were mainly due to the beneficial effects of probiotic supplementation.

Biochemical Composition – Lipid Content

The biochemical composition of fish muscle is an important indicator of nutritional quality and metabolic efficiency. In the present study, lipid content increased with increasing probiotic concentration. The highest lipid content (2.509) was recorded in Treatment III, while the lowest value (0.301) was observed in the control group.

The increase in lipid content may be attributed to improved nutrient digestion and assimilation mediated by probiotic bacteria. Probiotics enhance lipid metabolism by producing lipolytic enzymes and improving intestinal microbial balance.

Recent research by Ahmad *et al.,* (2023) and Zhang *et al.,* (2024) reported that probiotic supplementation significantly improves biochemical composition, including lipid and protein content, in cultured fish species.

TABLE 1 Effect of Probiotic Lactobacillussporogenes on growth parameters of LabeoRohita

| PARAMETERS | INITIAL WEIGHT(w1) g | FINAL WEIGHT (w2) g | GROWTH (w2-w1) g | GROWTH RATE - g/day | SPECIFIC GROWTH RATE | PERCENT INCREASE IN BODY WEIGHT |
|---|---|---|---|---|---|---|
| C | 3.1 | 4.2 | 1.1 | 0.039 | 1.08 | 35.48 |
| T1 | 3.4 | 4.9 | 1.5 | 0.054 | 1.30 | 44.12 |
| T2 | 3.7 | 5.5 | 1.8 | 0.064 | 1.41 | 48.65 |
| T3 | 4 | 6.2 | 2.2 | 0.079 | 1.56 | 55. |

Table2Food utilization Characteristics of rainbow trout fingerlings fed formulated feeds containing Tubifex.

| S.NO | PARAMETERS | C | T1 | T2 | T3 |
|---|---|---|---|---|---|
| 1 | FOOD CONSUMED (g) | 9.277 | 10.069 | 10.810 | 12.118 |
| 2 | FAECAL OUTPUT (g) | 9 | 8.681 | 7.750 | 6.632 |
| 3 | FOOD ABSORBED (g) | 0.277 | 1.388 | 3.060 | 5.486 |
| 4 | ABSORPTION RATE | 0.030 | 0.138 | 0.283 | 0.453 |
| 5 | FEEDING RATE | 0.33 | 0.36 | 0.39 | 0.43 |
| 6 | ABORPTION EFFICIENCY | 2.99 | 13.78 | 28.30 | 45.27 |
| 7 | GROSS CONVERSION EFFICIENCY | 11.866 | 14.89 | 16.65 | 18.16 |

Physico Chemical Parameters

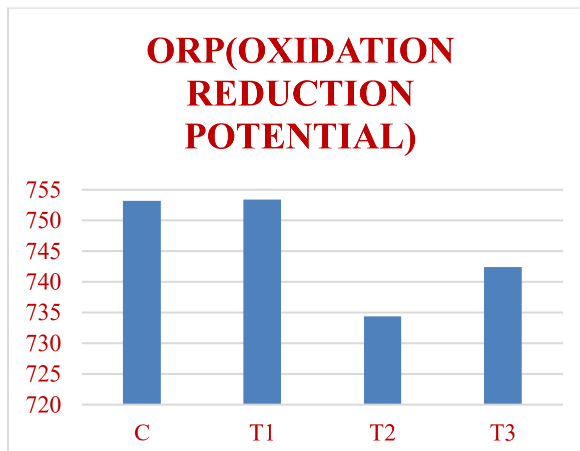


Figure 1

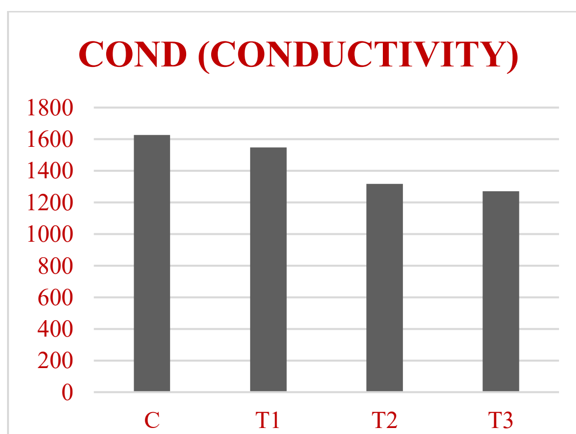


Figure 2

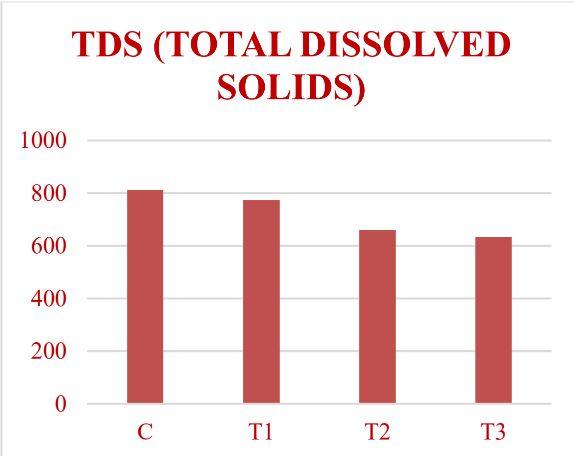


Figure 3

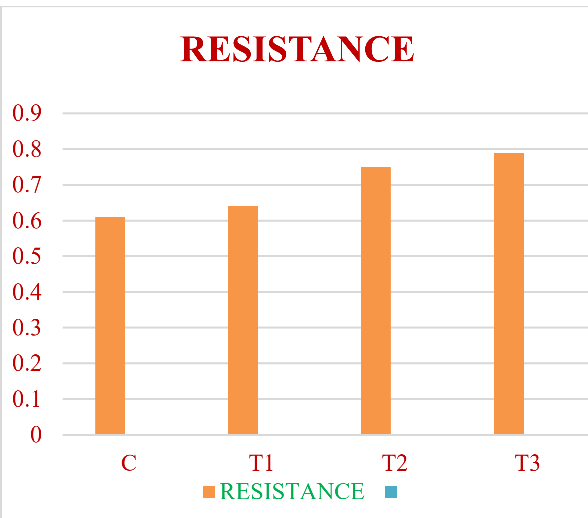


Figure 4

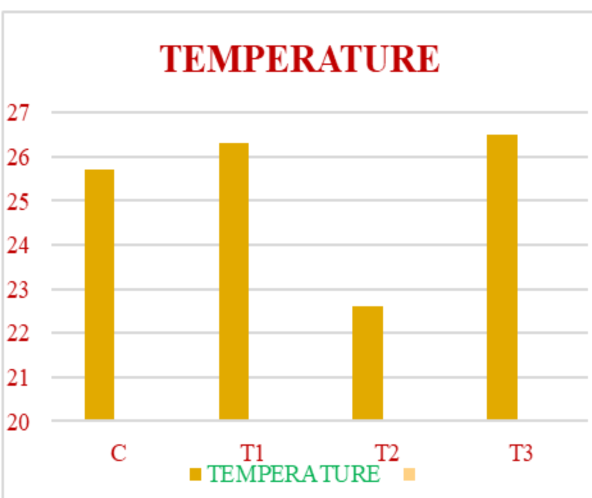


Figure 5

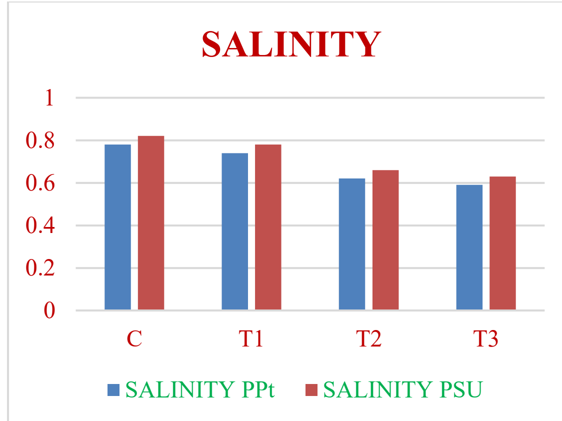


Figure 6

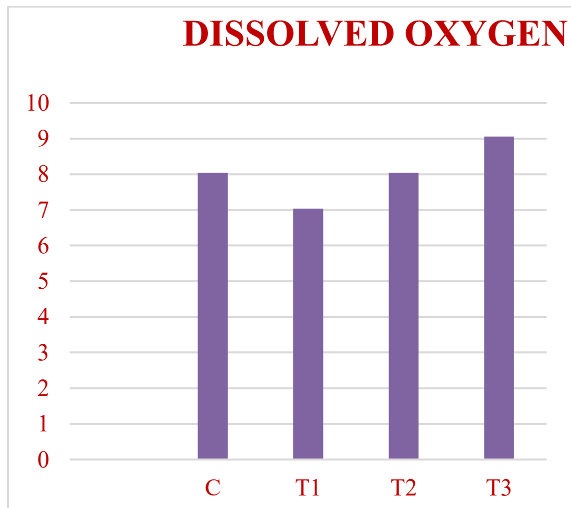


Figure 7

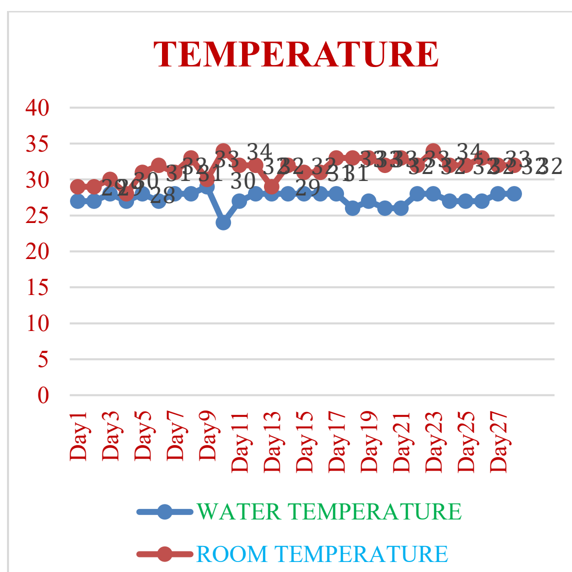


Figure 8

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