Journal for Re Attach Therapy and Developmental Diversities
eISSN: 2589-7799
2023 November; 6(9s): 1800-1810

Evaluation Of Physiochemical Traits And Biochemical Profiling In Key Carp Species Within The JLN Canal

Sonal Yadav[1], Naveen Kumar[2]*

[1]PhD Scholar, School of Basic and Applied Sciences, Raffles University, Neemrana, 301705
[2]*Assistant Professor, Department of Zoology, School of Basic and Applied Sciences, Raffles University, Neemrana, 301705. Email: Naveentak72@gmail.com

***Corresponding Author:** Naveen Kumar
*Assistant Professor, Department of Zoology, School of Basic and Applied Sciences, Raffles University, Neemrana, 301705. Email: Naveentak72@gmail.com

Abstract

This study investigates the intricate dynamics of the JLN Canal ecosystem, emphasizing the interrelationships among physicochemical parameters, phytoplankton diversity, and the biochemical composition of prominent Indian major carp species - *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*. The JLN canal, Rewari integral to the Jawahar Lal Nehru Lift Irrigation Project, provides a unique habitat for diverse aquatic life. Physicochemical analyses reveal a harmonious environment, while phytoplankton and zooplankton communities showcase dynamic variations along the canal. Biochemical assessments of the major carp species unveil gender-specific disparities in muscle and liver tissues, offering valuable insights for fisheries management and ecological conservation. This comprehensive investigation contributes to the broader understanding of anthropogenic canal ecosystems and their ecological intricacies.

INTRODUCTION

The utilization of artificial waterways in the form of canals serves a multitude of societal functions, including irrigation, drainage, navigation, and hydroelectric power generation. These canals play a vital role in providing freshwater for both domestic and industrial needs. However, the inherent fragility of canals becomes apparent due to their susceptibility to various potential disruptors such as pollution, sedimentation, erosion, and the impacts of climate change. Therefore, it is imperative to rigorously monitor and assess canal water quality by integrating a range of physicochemical parameters. This concerted effort is essential not only for preserving the delicate ecological equilibrium but also for safeguarding human well-being in a dynamic environment. Comprehensive analysis of key parameters such as pH levels, dissolved oxygen concentrations, turbidity, nutrient levels, and pollutant presence enables a profound understanding of the current state of canal ecosystems. This understanding provides crucial insights necessary for developing and implementing effective management and preservation strategies.

Physicochemical parameters serve as pivotal metrics for evaluating canal water quality. These parameters, integral to environmental monitoring, include pH (indicative of water acidity/alkalinity), temperature, conductivity (a measure of electrical resistance), turbidity (an indicator of cloudiness), dissolved oxygen (crucial for aquatic life), biochemical oxygen demand (reflecting organic matter consumption by microorganisms), chemical oxygen demand (demonstrating organic matter oxidation by chemical agents), total dissolved solids (quantifying dissolved salts and minerals), total hardness (specific to calcium carbonate or magnesium hydroxide precipitation), chloride (measuring chloride ion presence), sulfate (assessing sulfate ion concentration), and nitrate (emanating from fertilizers or animal waste). The values of these parameters are influenced by factors such as geographical location, seasonal variations, water source characteristics, treatment processes, and patterns of canal water utilization.

An investigation into the physicochemical attributes of Ganga Canal water quality at the Haridwar site was conducted, comparing it with conditions at two distinct locales: Bhimgoda Barrage (as the control site) and Bahadrabad (designated as the contaminated site). The latter receives water heavily laden with pollutants originating from industrial and commercial areas (Matta, Srivastava, Pandey, & Saini, 2017). The inquiry revealed significant disparities across various parameters, including turbidity, total solids, pH, dissolved oxygen, free CO_2, and total hardness, between the aforementioned locations. Furthermore, a substantial proportion of these parameters either adhered to or closely approached the permissible limits established by the Indian Standards Institution (ISI) and the World Health Organization (WHO) for drinking water quality. This underscores the overall adherence of Ganga Canal water to prevailing standards at the study site.

Numerous investigations have probed the environmental and ecological facets of canal systems, yielding crucial insights into their dynamics. In a comprehensive study, Arivoli et al. (2018) focused on evaluating the physicochemical parameters of Chennai's Buckingham Canal in Tamil Nadu, India, gathering monthly samples over a year (Arivoli, Dhinamala, Persis, Meeran, & Pandeeswari, 2018). While most parameters remained within acceptable limits, heightened turbidity levels exceeding permissible thresholds were identified. Seasonal variations were notably observed in temperature, conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total alkalinity, chloride, phosphate, and nitrate. In a distinct approach, Swain et al. (2022) employed geospatial and statistical methods to assess groundwater quality in Rajasthan, India, within a semi-arid region (Swain, Sahoo, & Taloor, 2022). Utilizing remote sensing data and GIS tools, the study mapped the spatial distribution of various groundwater quality parameters, identifying influential factors like land use type, distance from the source, and rainfall intensity through statistical analysis. Furthermore, the analysis of Medchal Lake in Telangana State underscored its significance as a natural freshwater source for nearby villages, encompassing various physicochemical parameters (Raju Potharaju, 2021). Additional investigations into the effects of sewage (Lopamudra, Keshari, Kumar, Kumar, & Debasmita, 2015) and tin oxide nanoparticles (Perva et al., 2020) on the biochemical profiles of Indian major carp species (*Labeo rohita* and *Catla catla*, respectively) revealed substantial alterations in the health and physiological responses of the fish. Another study by Kumari et al. (2018) explored the impacts of sublethal concentrations of copper sulfate on blood biochemical parameters in *Catla catla*, highlighting consequential effects on blood metabolism and liver function (Kumari, Krishna, Pathakota, Annam, & Kumar, 2018). Collectively, these studies significantly contribute to our understanding of the intricate environmental and biological dynamics inherent in canal ecosystems.

In this investigation, we delved into the physiochemical parameters, phytoplankton diversity, and their consequential influence on the biochemical composition of three prominent Indian major carps: *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* at JLN canal site (Figure 1).

MATERIALS AND METHODOLOGY

Materials

The Jawahar Lal Nehru Lift Irrigation Project (JLN) comprises a 53 km canal with a head discharge capacity of 25.75 cumec, situated in the Rewari district of Haryana, India. Spanning a command area of 2,49,901 hectares and boasting an ultimate irrigation potential of 1,54,640 hectares, this canal plays a pivotal role in sustaining a diverse array of fish species, including esteemed Indian major carps such as *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*. In order to unravel the intricate dynamics of this ecosystem, a comprehensive study was initiated during the summer months from June to August 2021 and continued annually until its completion in 2023 (see Table 4.1) at JLN canal Bridge over a span of 10 acres area nearby bridge (Figure 1). Each session involved the meticulous collection of ten samples (n=10) for both water and fish (10 each for male and female), enabling a temporal breadth that captured nuanced variations in environmental conditions and ecological dynamics across multiple seasons. Executed with precision and scientific rigor, the investigation employed a robust sampling methodology. The collected samples served as microcosmic snapshots, encapsulating the multifaceted aspects of the lake's physiochemical composition, the diversity of phytoplankton and zooplankton, and the biochemical intricacies of key carp species—*Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*.

Investigation of physio-chemical parameters

In the exploration of physio-chemical attributes, a meticulous sampling methodology was employed to gain comprehensive insights. Water samples were carefully gathered using sterile, wide-mouth, screw-capped glass containers to ensure precision in sampling at depths ranging from 1 to 2 meters. The selection of sampling sites was judiciously conducted in close proximity to both the water surface and canal, with deliberate spacing of several meters between each collection point, maintaining a significant geographical separation of several kilometers between two points. Utilizing the Van Dorn Sampler during the tranquil early morning hours, specifically between 5 to 6 AM, facilitated precise sample collection (Bhatnagar & Singh, 2010; Manickam, Sarvana, Santhanam, Huvaneshwari, & Chitrarasu, 2017). Post-extraction, immediate transfer of water samples under refrigerated conditions was ensured to preserve their inherent characteristics. Upon arrival at the laboratory, the physio-chemical parameters of the water samples were promptly analyzed on the same day as collection. On-site measurements of atmospheric and surface water temperatures were recorded using a thermometer. The quantification of pH, salinity, electrical conductivity (EC), total dissolved solids (TDS), and dissolved oxygen (DO) was executed using the "µP Based Water and Soil Analysis Kit Model-1160." This systematic and rigorous approach played a pivotal role in upholding the integrity of the samples, ensuring precise assessments of the lake's physio-chemical composition.

Analysis of phytoplankton and zooplankton sample

Planktonic specimens were methodically obtained by filtering 25 liters of water collected from five distinct locations within the canal. Utilizing a plankton net with a mesh size of 50 µm, following the procedures outlined by Bhatnagar and Singh (2010) and Manickam et al. (2017), facilitated a comprehensive evaluation of plankton diversity (Bhatnagar & Singh, 2010; Manickam et al., 2017). Subsequent to collection, the samples were carefully transferred to a measuring cylinder, and a standardized volume of 50 ml was achieved using distilled water. Preservation involved storing these samples in small plastic containers treated with a 5% buffered formalin solution to ensure the integrity of the specimens. For quantitative plankton analysis, the Sedgwick Rafter cell method was employed, providing a robust framework for estimating numerical density in each sample. This systematic approach allowed for an in-depth exploration of plankton dynamics within the pond ecosystem, offering valuable insights that contribute to a broader understanding of aquatic ecosystems. In the laboratory, phytoplankton samples underwent meticulous taxonomic classification using a binocular stereo zoom dissection microscope, leading to the identification of taxa such as Diatoms, Green Algae, and Cyanobacteria. Further taxonomic refinement occurred under a compound microscope with magnifications ranging from 40X to 100X, culminating in the capture of photomicrographs facilitated by an Inverted Biological Microscope equipped with a camera. This refined methodology significantly enhances our comprehension of the lake's phytoplankton composition, providing nuanced ecological insights. Similarly, zooplankton assemblages, including Crustaceans and Insects, underwent thorough identification using a binocular stereo zoom dissection microscope in the laboratory. Post-staining, individual species were meticulously mounted on slides, and precise taxonomic identification was achieved with the aid of standard manuals and textbooks using a compound microscope, complemented by photomicrography. This comprehensive approach ensures a thorough understanding of the lake's zooplankton composition, contributing to the broader ecological narrative.

Biochemical analysis of carps

Samples representing mature developmental stages of *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* (n=10) were acquired from the lake using nets for subsequent examination following stringent analytical protocols. To uphold biological fidelity, each individual carp underwent immediate preservation on ice and was transported to the laboratory. Methodical dissection focused on retrieving dorsal muscle and liver tissues, which were hermetically sealed in polyethylene bags and stored at an ultra-low freezing temperature of -80 °C to maintain biochemical integrity. The determination of ash content involved incineration in a muffle furnace at 550 °C for 10 hours, following the methodology delineated by Egan et al. (1981) (Egan, Cox, & Pearson, 1981). Protein content quantification adhered to the procedure outlined by Lowry et al. (1951) (Ch, 1951), while assessment of total lipid and fatty acid content followed the methods proposed by Kandemir and Polat (2007) (Kandemir & Polat, 2007). Biochemical composition and fatty acid quantities for both muscle and liver tissues were assessed on a wet weight basis and expressed as percentages. Moisture content analysis adhered to the standards established by the Association of Official Analytical Chemists (AOAC) in 1970 (Baker & Chesnin, 1976). This comprehensive analytical framework seeks to offer a nuanced comprehension of the inherent biochemical composition within the examined fish species.

Statistical analysis

The provided data underwent meticulous statistical scrutiny employing GraphPad Prism 5.0 to determine its statistical significance. Subsequently, a one-way analysis of variance (ANOVA) was performed, followed by the Tukey test to identify significant differences among means, with a confidence level established at 5% ($p < 0.05$).

RESULTS

Site characteristics of JLN Canal Site

Within the opulent expanse of the Jawahar Lal Nehru Canal, an artificially constructed watercourse weaving through the Rewari District of Haryana, India, a panorama of ecological wonders unfolds across its approximately 50-kilometer span (Mindat, 2023). The canal plays a pivotal role in the Jawahar Lal Nehru Lift Irrigation Project, extending from Khubaru to the 1st Lift Station JF-1 at Akedi Madanpur, and further to JF-2 at Salawas Rewari. Beyond its functional infrastructure, this aquatic habitat acts as a haven for a diverse array of piscine life, encompassing species like Labeo, Catla, Cirrhinus, Silver Carp, and Grass Carp, among others. The riparian ecosystem, intricately woven with the lively tapestry of indigenous flora and fauna, provides a habitat for numerous avian species. Amidst this aqueous panorama, reptilian inhabitants carve out their ecological niche, emphasizing the nuanced interdependence within this carefully engineered canal system (Indiawris, 2023). This intricate fusion of technological innovation and natural splendor exemplifies the symbiotic balance between human intervention and ecological richness, thereby presenting the Jawahar Lal Nehru Canal as a testament to the harmonious coexistence of infrastructure and biodiversity in the Nature Journal style (Figure 1).

Physiochemical parameters of the canal

Investigation of the JLN Canal has yielded profound insights into the environmental dynamics of this aquatic ecosystem. Immersed within nature's crucible, our measurements unveil a nuanced interplay of parameters that influence the well-being of the ecosystem. Our attention is directed towards the intricate dance of temperatures in both the air and on the water's surface. The average atmospheric temperature surrounding the canal is recorded at 26.33 ± 4.08 °C, creating a warm embrace. Beneath the surface, the water maintains a milder demeanor with an average temperature of 20.63 ± 6.21 °C. This temperature interplay provides a glimpse into the delicate equilibrium essential for the thriving biodiversity within these waters (Figure 2).

The canal water, resembling a silent canvas, maintains a neutral pH value of 7.60 ± 0.20, indicating a harmonious environment for diverse aquatic organisms. However, upon closer examination, intricacies emerge. Salinity, electrical conductivity (EC), and total dissolved solids (TDS) contribute their nuances to the symphony of data. Salinity subtly touches 1.83 ± 0.37, while EC and TDS measure 1500 ± 250 and 280.00 ± 65.57, respectively. These values provide insight into the mineral composition influencing overall water health. Dissolved oxygen (DO) assumes a pivotal role, exhibiting a mean value of 4.07 ± 0.21 (Figure 2). This oxygen supply is critical for aquatic inhabitants, and variations may signal shifts in the ecosystem's dynamics.

Delving into the carbon realm, the concentration of free CO2 paints a picture of 29.20 ± 4.36. Simultaneously, biochemical oxygen demand (BOD) whispers its presence at 5.71 ± 0.48. These carbon cycling indicators underscore the intricate interplay between flora and fauna in their competition for resources. Minerals, the unobtrusive architects of aquatic health, command attention. Concentrations of various minerals, including Bicarbonates (352.00 ± 68.43), Carbonates (27.75 ± 6.50), Calcium (43.33 ± 9.00), Chloride (6.85 ± 1.44), o-phosphate (0.052 ± 0.019), Total phosphate (1.443 ± 0.295), and Total ammonia (1.66 ± 0.35), as depicted in Figure 3, offer a comprehensive portrayal of the chemical landscape of JLN Canal. Total alkalinity (74.0 ± 7.5) and hardness (148.00 ± 23.73), stalwart defenders of water stability, signify the canal's resilience against external changes and play a pivotal role in sustaining life.

Phytoplankton and Zooplankton diversity

In the exploration of the phytoplankton community structure along the JLN canal, which encompasses a diverse assemblage of Diatoms, Green Algae, and Cyanobacteria, a nuanced understanding has been achieved through the elucidation of distinct quantitative metrics. The quantification of Diatoms revealed a numerical density of 1536.33 ± 283.11 cells/L, providing insights into their prevalence within this ecosystem. Similarly, Green Algae exhibited a quantifiable count of 351.33 ± 57.29 cells/L, yielding valuable data on their population dynamics. The presence of Cyanobacteria was determined at a concentration of 64.00 ± 35.41 cells/L (Figure 4), significantly contributing to the comprehensive characterization of the phytoplankton community. Simultaneously, a thorough examination of zooplankton cohorts, with a particular focus on Crustaceans and Insects, has unveiled noteworthy revelations. The abundance of Crustaceans, exemplified by a documented count of 992.67 ± 448.54 individuals/L, underscores their pivotal role in the ecological dynamics of the canal. Additionally, Insects, as an integral component of the zooplankton community, exhibited a count of 340.00 ± 94.34 individuals/L, providing clarification on their population distribution.

Biochemical parameters of *Catla catla*

Muscle and liver specimens from *Catla catla* were meticulously examined using established methodologies in a comprehensive biochemical analysis. The scrutiny of male muscle tissue involved quantifying pivotal constituents, including Moisture, Ash, Protein, Lipid, and Fatty acids, resulting in levels of 75.945 ± 1.275, 1.29 ± 0.05, 17.61 ± 0.37, 4.11 ± 0.01, and 60.74 ± 3.485, respectively (Figure 5). A parallel assessment of female muscle tissue revealed corresponding values of 75.68 ± 0.69, 2.955 ± 0.185, 16.27 ± 0.05, 3.52 ± 0.26, and 59.74 ± 3.525. Shifting focus to the analysis of male liver tissue, recorded levels were determined as 68.74 ± 1.48 for Moisture, 0.79 ± 0.025 for Ash, 12.64 ± 0.47 for Protein, 4.58 ± 0.40 for Lipid, and 58.45 ± 4.19 for Fatty acids. In the case of female liver samples, values were determined to be 69.26 ± 0.28 for Moisture, 0.66 ± 0.09 for Ash, 13.38 ± 0.4 for Protein, 4.705 ± 0.585 for Lipid, and 61.41 ± 5.81 for Fatty acids. This meticulous biochemical analysis provides insights into the composition of muscle and liver tissues in *Catla catla*, elucidating gender-specific variations in the levels of essential biochemical constituents.

Biochemical parameters of *Labeo rohita*

This study conducted a comprehensive analysis of the biochemical composition inherent in the muscle and liver tissues of *Labeo rohita*. Quantitative assessments of male musculature revealed the following values for Moisture, Ash, Protein, Lipid, and Fatty Acid content: 81.21 ± 0.985, 1.12 ± 0.1, 16.68 ± 0.46, 1.85 ± 0.28, and 61.645 ± 2.475, respectively (Figure 6). In contrast, female musculature exhibited values of 82.20 ± 0.94, 1.22 ± 0.045, 17.33 ± 0.84, 2.35 ± 0.37, and 57.26 ± 0.985 for the corresponding parameters. In the male hepatic tissue domain, documented levels were recorded at

83.67 ± 0.45 for Moisture, 4.66 ± 0.45 for Ash, 15.72 ± 0.455 for Protein, 5.57 ± 0.40 for Lipid, and 61.55 ± 2.57 for Fatty Acid. Conversely, female hepatic tissue displayed concentrations of 83.21 ± 1.065, 4.96 ± 0.23, 14.69 ± 0.57, 5.68 ± 0.46, and 60.62 ± 3.5 for the respective parameters. The observed variations in biochemical profiles between genders within muscle and liver tissues provide intriguing avenues for further physiological exploration.

Biochemical parameters of *Cirrhinus mrigala*

In this investigation, a thorough analysis was undertaken to elucidate the biochemical composition of muscle and liver tissues derived from *Cirrhinus mrigala* specimens. The assessment of male muscle tissue revealed the following levels: Moisture (75.72 ± 0.5), Ash (3.77 ± 2.17), Protein (17.25 ± 0.985), Lipid (3.60 ± 0.38), and Fatty acid (68.175 ± 0.995) (Figure 7). In contrast, the female muscle tissue exhibited slightly divergent values, with Moisture at 75.51 ± 1.24, Ash at 3.11 ± 0.13, Protein at 16.79 ± 0.45, Lipid at 3.13 ± 0.99, and Fatty acid at 66.14 ± 3.49. Shifting the focus to the liver tissue, the biochemical parameters in males were determined as follows: Moisture (73.74 ± 0.52), Ash (2.64 ± 0.49), Protein (14.79 ± 0.375), Lipid (6.38 ± 0.4), and Fatty acid (56.515 ± 1.245). In the female liver tissue, the corresponding values were Moisture (74.73 ± 0.56), Ash (2.66 ± 0.07), Protein (14.98 ± 1.19), Lipid (6.85 ± 0.365), and Fatty acid (53.74 ± 2.52). These findings provide a comprehensive insight into the biochemical profile of *Cirrhinus mrigala* tissues, highlighting notable distinctions between male and female specimens regarding their muscle and liver composition.

DISCUSSION

In anthropogenically altered canal landscapes, ecosystems unfold as complex aquatic habitats shaped by human-engineered water channels designed for purposes such as irrigation, transportation, and drainage. These environments support a diverse range of plant and animal life, showcasing their ability to adapt to the unique conditions imposed by human-altered water systems (Singh & Chaturvedi, 2017). Flourishing in close proximity to the canals, aquatic vegetation serves dual functions as both habitat and nourishment for a diverse array of organisms. Within the canal waters, a varied assembly of fish species, including both native and introduced varieties, coexists, contributing to the overall biodiversity of these intricately interconnected ecosystems (Nag & Bhattacharjya, 2023). The physicochemical characteristics of the JLN Canal encompass parameters such as water pH, dissolved oxygen levels, and nutrient concentrations, which serve as crucial indicators of ecological well-being (Mindat, 2023) (Figure 1). Diligent monitoring of these parameters is essential for understanding water quality dynamics and ensuring the sustainability of the canal ecosystem. Exploration of the JLN Canal has provided a nuanced understanding of its environmental conditions (Indiawris, 2023). The interplay between atmospheric and water temperatures has revealed a delicate balance essential for the flourishing of aquatic life. Maintaining a neutral pH of 7.60, the canal offers a harmonious environment. However, the introduction of salinity, electrical conductivity (EC), and total dissolved solids (TDS) adds complexity, indicating the critical mineral composition for overall water health (Verma, Khanan, & Shukla, 2012) (Figure 2). Fluctuations in dissolved oxygen (DO), with a mean value of 4.07, emphasize its crucial role in supporting aquatic inhabitants. Carbon parameters, including free CO_2 (29.20) and biochemical oxygen demand (BOD) (5.71), shed light on the intricate dynamics of carbon cycling within the ecosystem (Verma et al., 2012). Mineral concentrations, encompassing bicarbonates, carbonates, calcium, chloride, o-phosphate, total phosphate, and total ammonia, offer a comprehensive portrayal of the chemical milieu (Figure 3). Total alkalinity (74.0) and hardness (148.00) underscore the canal's resilience against external perturbations, highlighting its pivotal role in sustaining life within this aquatic habitat (Ahmed et al., 2010).

In the ecological framework of the JLN Canal, the intricate interplay of physicochemical parameters and the diverse assembly of phytoplankton and zooplankton assumes a pivotal role in shaping nutrient cycling and sustaining higher trophic levels. Perturbations in water pH and nutrient concentrations exert direct influences on the abundance and composition of these microorganisms, emphasizing the critical necessity of maintaining a stable environment, which is a key determinant in preserving the overarching biodiversity intrinsic to the canal. Systematic exploration of the JLN Canal has unveiled detailed insights into the communities of phytoplankton and zooplankton, providing a comprehensive understanding of the ecological milieu. The quantitative assessment of phytoplankton reveals a mean abundance of 732.44 cells/L, accompanied by a notable standard deviation of 549.42 cells/L (Figure 4), elucidating the variability in phytoplankton population dynamics along the canal and implying dynamic ecological conditions. Simultaneously, a thorough examination of zooplankton cohorts, with a specific emphasis on Crustaceans and Insects, has yielded substantial revelations. The zooplankton populace, characterized by a mean of 1085.83 cells/L and a standard deviation of 445.98 cells/L, underscores the diverse and dynamic nature inherent in these communities within the JLN Canal. These empirical findings significantly contribute to a nuanced understanding of the ecological dynamics governing the canal, highlighting the intricate interplay between phytoplankton and zooplankton populations (Zhao et al., 2018).

In canal ecosystems, the complex interaction of physicochemical parameters and the diverse assembly of phytoplankton and zooplankton plays a profound role in influencing the biochemical composition of fish (Sarvala, Helminen, Saarikari, Salonen, & Vuorio, 1998). Changes in water quality have direct impacts on the moisture content, ash composition, protein levels, lipid content, and fatty acid profiles within the musculature and hepatic tissues of fish (Azimi & Rocher, 2016). A stable and nutrient-rich environment enhances the nutritional quality of fish tissues, while variations in these conditions may lead to alterations in the aforementioned biochemical parameters. A comprehensive understanding of these intricate relationships is imperative for a thorough assessment of the overall health and nutritional status of fish populations inhabiting canal ecosystems.

The comprehensive biochemical analysis of muscle and liver specimens from *Catla catla* has revealed gender-specific differentiations in the composition of essential biochemical constituents. In the examination of muscle tissues, male specimens exhibited slightly higher levels of Moisture (75.945 ± 1.275) compared to their female counterparts (75.68 ± 0.69). Conversely, females demonstrated elevated values in Ash (2.955 ± 0.185) relative to males (1.29 ± 0.05) ($p<0.05$). Substantial disparities were also observed in Protein, Lipid, and Fatty acid content, with males displaying elevated levels in Protein (17.61 ± 0.37) and Lipid (4.11 ± 0.01), while females manifested a slightly increased Fatty acid content (59.74 ± 3.525) (Figure 5) ($p<0.05$). Shifting focus to hepatic tissues, gender-specific distinctions persisted, delineating nuanced variations in Moisture, Ash, Protein, Lipid, and Fatty acid levels. These findings provide valuable insights into the biochemical constitution of muscle and liver tissues in *Catla catla*, emphasizing the importance of considering gender-specific variations in future studies and fisheries management strategies ($p<0.05$). Comparable alterations in diverse biochemical parameters between male and female fish have been previously documented, and notably, our results align with these earlier observations (Pradhan, Patra, & Pal, 2015). Additionally, multiple investigations have explored the diverse effects of various toxic substances, such as Deltamethrin (Kavitha, Malarvizhi, Kumaran, & Ramesh, 2010), mercury chloride (Prasath & Arivoli, 2008), and arsenate (Kavitha et al., 2010), on the biochemical parameters of *Catla catla*. These studies shed light on the remarkable sensitivity of its biochemical profile to these toxic agents.

Additionally, this investigation involved a thorough scrutiny of the biochemical constituents in the muscle and hepatic tissues of *Labeo rohita*, uncovering significant variations between male and female specimens. Quantitative analyses in male musculature revealed differences in Moisture (81.21 ± 0.985 vs. 82.20 ± 0.94), Ash (1.12 ± 0.1 vs. 1.22 ± 0.045), Protein (16.68 ± 0.46 vs. 17.33 ± 0.84), Lipid (1.85 ± 0.28 vs. 2.35 ± 0.37), and Fatty Acid content (61.645 ± 2.475 vs. 57.26 ± 0.985) compared to female musculature (Figure 6) ($p<0.05$). Similarly, distinctions were observed in hepatic tissues, with variations in Moisture (83.67 ± 0.45 vs. 83.21 ± 1.065), Ash (4.66 ± 0.45 vs. 4.96 ± 0.23), Protein (15.72 ± 0.455 vs. 14.69 ± 0.57), Lipid (5.57 ± 0.40 vs. 5.68 ± 0.46), and Fatty Acid content (61.55 ± 2.57 vs. 60.62 ± 3.5) between male and female specimens ($p<0.05$). These identified differences in biochemical profiles across genders within muscle and liver tissues provide intriguing avenues for subsequent physiological exploration, suggesting potential sex-related dissimilarities in the metabolic and nutritional attributes of *Labeo rohita*. In a recent study conducted in the Lentic Water Bodies of the Indus River at Ghazi Ghat, Pakistan, the impact of feeding habits, size, and seasonal variations on the body composition of *Labeo rohita* was investigated (Hussain et al., 2016). The study unveiled noticeable changes in various biochemical parameters, offering valuable insights into the intricate dynamics of this aquatic ecosystem. Furthermore, a comparative analysis of the body composition, hemato-biochemical profile, and growth performance of Common Carp cultured under distinct feeding regimes and habitats, specifically utilizing biofloc technology and earthen pond systems, revealed parallel alterations (Habib, Batool, Rehman, & Naz, 2023).

Moreover, a thorough examination of the biochemical composition of *Cirrhinus mrigala* tissues revealed discernible disparities between male and female specimens, as well as variations within muscle and liver tissues. Subtle distinctions emerged in the analysis of muscle tissue, where males exhibited slightly elevated levels of Ash and Fatty acids compared to females. Specifically, male muscle tissue displayed values for Moisture (75.72 ± 0.5), Ash (3.77 ± 2.17), Protein (17.25 ± 0.985), Lipid (3.60 ± 0.38), and Fatty acids (68.175 ± 0.995), while female muscle tissue exhibited corresponding values for Moisture (75.51 ± 1.24), Ash (3.11 ± 0.13), Protein (16.79 ± 0.45), Lipid (3.13 ± 0.99), and Fatty acids (66.14 ± 3.49) (Figure 7) ($p<0.05$). Shifting focus to liver tissue, gender-based differentials persisted, with male liver tissue displaying heightened levels of Ash, Lipid, and Fatty acids compared to their female counterparts ($p<0.05$). The intricate characterization of male liver tissue encompassed Moisture (73.74 ± 0.52), Ash (2.64 ± 0.49), Protein (14.79 ± 0.375), Lipid (6.38 ± 0.4), and Fatty acids (56.515 ± 1.245), while female liver tissue presented values for Moisture (74.73 ± 0.56), Ash (2.66 ± 0.07), Protein (14.98 ± 1.19), Lipid (6.85 ± 0.365), and Fatty acids (53.74 ± 2.52) ($p<0.05$). These findings underscore the significant implications of gender-related distinctions in the biochemical composition of *Cirrhinus mrigala*, providing valuable insights into the nuanced variations within muscle and liver tissues of this species. The study conducted in the Indus River at Ghazi Ghat, Pakistan, illuminated the impact of feeding habits, size, and seasonal variations on the body composition of *Cirrhinus mrigala* (Hussain et al., 2016). Furthermore, a comprehensive review investigating the seasonal impact on diverse fish species in South Asia has revealed noteworthy variations, emphasizing the influence of gender and tissue type on the intricate biochemical composition of these fish species (Rasul et al., 2021).

CONCLUSION

In the JLN Canal, monitoring water pH, dissolved oxygen, and nutrient levels is crucial for ecological health. Maintaining a neutral pH of 7.60 and considering factors like salinity and mineral composition are vital. The diverse phytoplankton and zooplankton in the canal influence nutrient cycling and higher trophic levels. Physicochemical perturbations directly impact these microorganisms, emphasizing the need for a stable environment to preserve biodiversity and fish diversity. Biochemical analysis of fish reveals how water quality changes affect musculature and hepatic tissues. Understanding these intricacies is essential for evaluating fish health in canal ecosystems. Gender-specific differences in the biochemical composition of *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* tissues highlight the importance of incorporating such variations in future studies and fisheries management.

Funding: This work was not supported by any funding.

Data availability statement: This published article encompasses all the data gathered throughout this experimental study.

Conflict of interests: The authors have no relevant conflict of interest to disclose.

References

1. Ahmed, M., Ahsan, A., Haque, M., Siraj, S., Bhuiyan, M., Bhattacharjee, S., & Islam, S. (2010). Physicochemical assessment of surface and groundwater quality of the greater Chittagong region of Bangladesh. Pakistan Journal of Analytical & Environmental Chemistry, 11(2), 11.
2. Arivoli, S., Dhinamala, K., Persis, D., Meeran, M., & Pandeeswari, M. (2018). Analysis of physicochemical water quality parameters of Buckingham Canal, Chennai, Tamil Nadu, India. International Journal of Zoology Studies, 3(1), 226-231.
3. Azimi, S., & Rocher, V. (2016). Influence of the water quality improvement on fish population in the Seine River (Paris, France) over the 1990–2013 period. Science of The Total Environment, 542, 955-964.
4. Baker, D. E., & Chesnin, L. (1976). HUMAN HEALTH1. Advances in Agronomy, 305.
5. Bhatnagar, A., & Singh, G. (2010). Assessment of culture fisheries in village ponds: a study in district Hisar, Haryana, India.
6. Ch, L. (1951). Protein measurement with Folin phenol reagent. J Biol Chem, 193, 265-275.
7. Egan, H., Cox, H. E., & Pearson, D. (1981). Pearson's chemical analysis of foods.
8. Habib, S. S., Batool, A. I., Rehman, M. F. U., & Naz, S. (2023). Comparative analysis of hemato-biochemical profile, growth performance, and body composition of Common Carp cultured under different feed and habitats (biofloc technology and earthen pond systems). North American Journal of Aquaculture, 85(3), 277-290.
9. Hussain, M. Z., Naqvi, A. A., Shahzadah, W. A., Latif, A., Hussain, S., Iqbal, R., & Ali, M. (2016). Effect of feeding habit, size and season on proximate composition of commercially important fishes from lentic water bodies of Indus river at ghazi ghat, Pakistan. Pakistan Journal of Zoology, 48(6).
10. Indiawris. (2023). Jawahar Lal Nehru Lift Irrigation Project JI01670. Retrieved from https://indiawris.gov.in/wiki/doku.php?id=jawahar_lal_nehru_lift_irrigation_project_ji01670
11. Kandemir, Ş., & Polat, N. (2007). Seasonal Variation of Total Lipid and Total Fatty Acid in Muscle and Liver of Rainbow Trout (Oncorhynchus mykiss W, 1792) Reared in Derbent Dam Lake. Turkish Journal of Fisheries and Aquatic Sciences, 7(1).
12. Kavitha, C., Malarvizhi, A., Kumaran, S. S., & Ramesh, M. (2010). Toxicological effects of arsenate exposure on hematological, biochemical and liver transaminases activity in an Indian major carp, Catla catla. Food and Chemical Toxicology, 48(10), 2848-2854.
13. Kumari, K., Krishna, G., Pathakota, G. B., Annam, P. K., & Kumar, S. (2018). Acute toxicity of copper sulphate on Catla catla larvae and its effect on expression of three commonly used housekeeping genes.
14. Lopamudra, B., Keshari, R. S., Kumar, T. R., Kumar, D. B., & Debasmita, J. (2015). Impact of sewage on certain biochemical profiles of Indian major carp, Labeo rohita (HAMILTON). International Research Journal of Biological Sciences, 4(8), 33-39.
15. Manickam, N., Sarvana, B., Santhanam, P., Huvaneshwari, R., & Chitrarasu, P. (2017). Physico-chemical characteristics and phytoplankton biodiversity in Sulur lake of Coimbatore, South India. Research Journal of Biotechnology, 12(11), 72-82.

16. Matta, G., Srivastava, S., Pandey, R., & Saini, K. (2017). Assessment of physicochemical characteristics of Ganga Canal water quality in Uttarakhand. Environment, development and sustainability, 19, 419-431.
17. Mindat. (2023). Jawāharlal Nehru Canal, State of Haryāna, India. Retrieved from https://www.mindat.org/feature-10553638.html
18. Nag, S. K., & Bhattacharjya, B. K. (2023). PROSPECTS AND POTENTIAL OF CANAL RESOURCES FOR FISH PRODUCTION AND RELATED ENVIRONMENTAL ISSUES.
19. Perva, S., Swamy, K., Chandrashekar, N., Subramanian, R., Sukumaran, S., & Chandra SP, S. (2020). Physio-biochemical responses of Indian major carp Catla catla upon sub-chronic exposure to tin oxide nanoparticles. Egyptian Journal of Aquatic Biology and Fisheries, 24(4), 509-520.
20. Pradhan, S. C., Patra, A. K., & Pal, A. (2015). Seasonal analysis of the biochemical composition of muscle and liver of Catla catla in a tropical climate of India. Comparative Clinical Pathology, 24, 593-603.
21. Prasath, P. M. D., & Arivoli, S. (2008). Biochemical study of freshwater fish Catla catla with reference to mercury chloride. Journal of Environmental Health Science & Engineering, 5(2), 109-116.
22. Raju Potharaju, M. A. (2021). Analysis of Physico Chemical Parameters of Medchal Lake in Telangana State.
23. Rasul, M. G., Jahan, I., Yuan, C., Sarkar, M. S. I., Bapary, M. A. J., Baten, M. A., & Shah, A. A. (2021). Seasonal variation of nutritional constituents in fish of South Asian Countries: A review. Fundamental and Applied Agriculture, 6(2), 193–209-193–209.
24. Sarvala, J., Helminen, H., Saarikari, V., Salonen, S., & Vuorio, K. (1998). Relations between planktivorous fish abundance, zooplankton and phytoplankton in three lakes of differing productivity. Paper presented at the Eutrophication in Planktonic Ecosystems: Food Web Dynamics and Elemental Cycling: Proceedings of the Fourth International PELAG Symposium, held in Helsinki, Finland, 26–30 August 1996.
25. Singh, J., & Chaturvedi, R. (2017). Diversity of ecosystem types in India: a review. Proceedings of the Indian National Science Academy, 83(2), 569-594.
26. Swain, S., Sahoo, S., & Taloor, A. K. (2022). Groundwater quality assessment using geospatial and statistical approaches over Faridabad and Gurgaon districts of National Capital Region, India. Applied water science, 12(4), 75.
27. Verma, O., Khanan, B., & Shukla, S. (2012). Determination of physico-chemical characteristics of four canals of Allahabad region and its suitability for irrigation. Advances in applied science research, 3(3), 1531-1537.
28. Zhao, K., Wang, L., Riseng, C., Wehrly, K., Pan, Y., Song, K., . . . Tian, H. (2018). Factors determining zooplankton assemblage difference among a man-made lake, connecting canals, and the water-origin river. Ecological indicators, 84, 488-496.

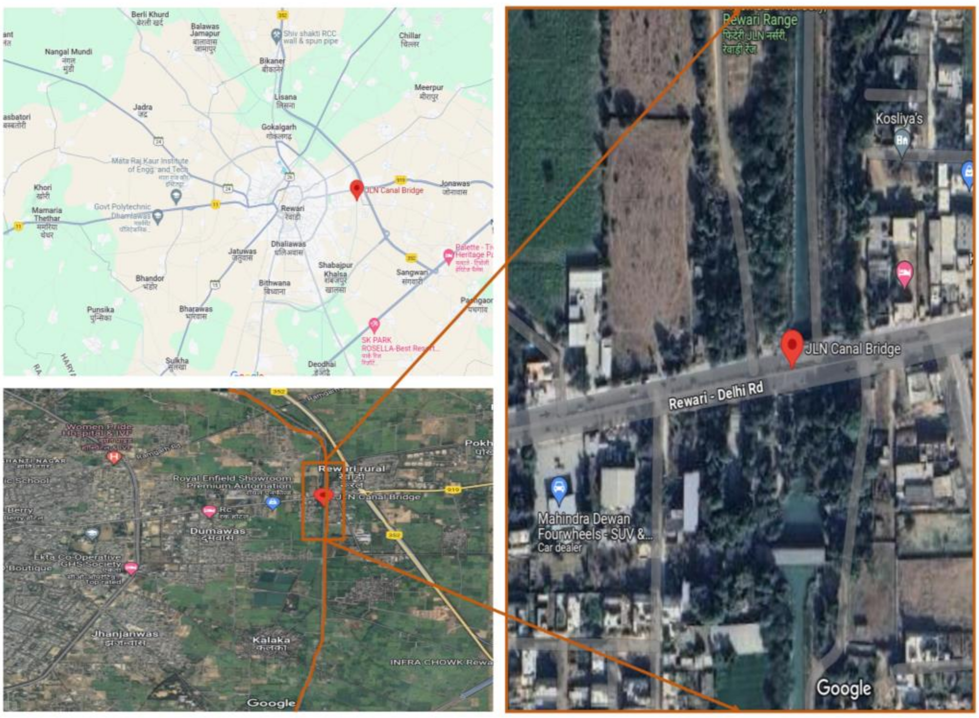

Figure 1. Displays the google map view of the site 1 JLN canal.

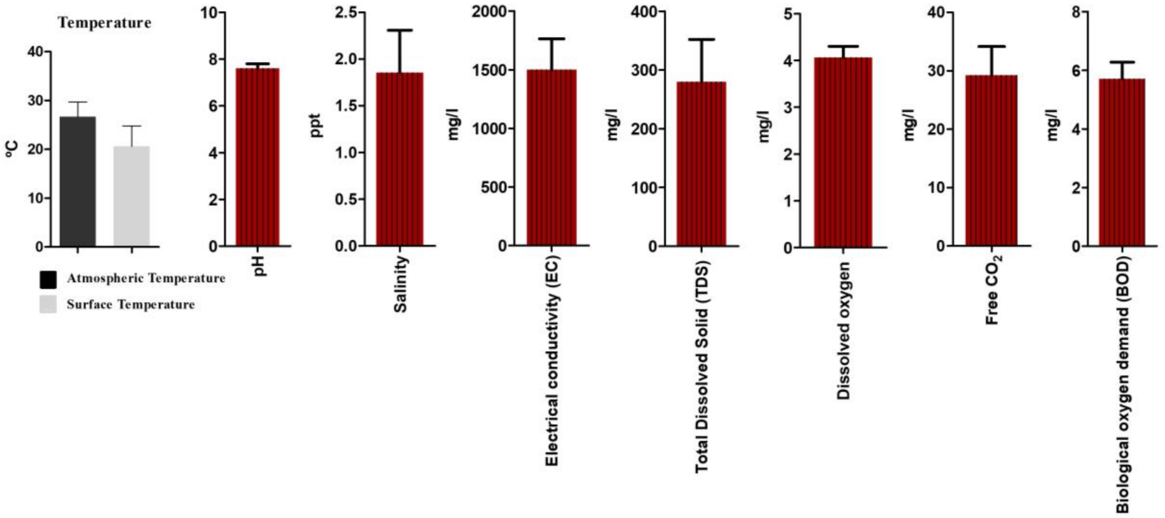

Figure 2. illustrates the physicochemical components of the JLN canal, offering insights into its biochemical composition.

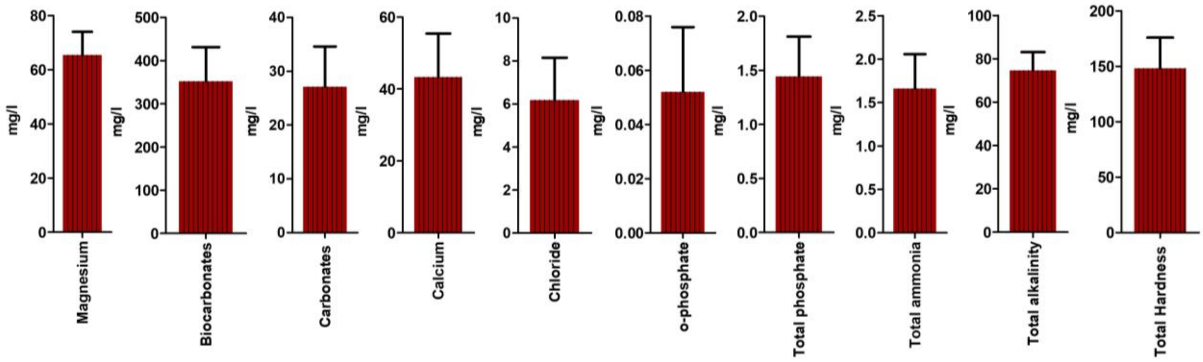

Figure 3. presents the mineral constituents of the JLN canal, providing a comprehensive view of its mineral composition.

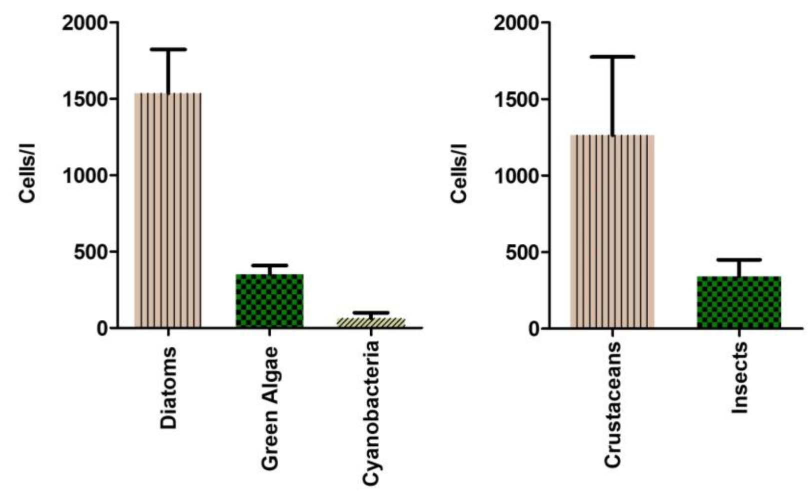

Figure 4. showcases the diversity of phytoplankton and zooplankton in the JLN canal, contributing to a nuanced understanding of the aquatic ecosystem.

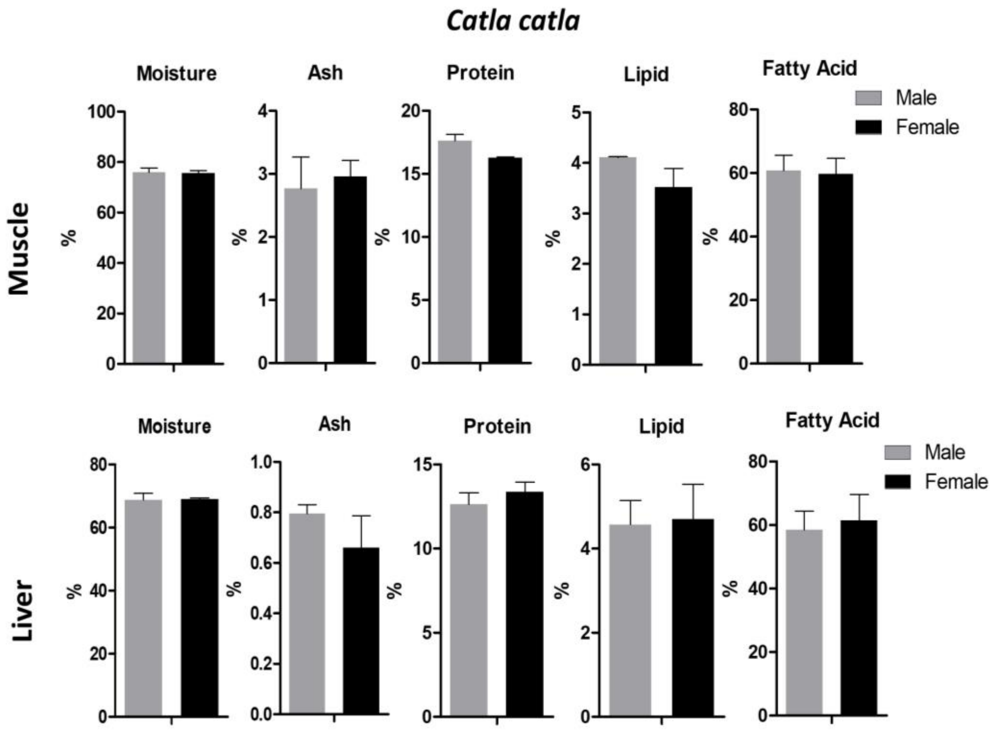

Figure 5. delineates the biochemical composition of *Catla catla* within the JLN canal, shedding light on the intricate physiological aspects of this fish species.

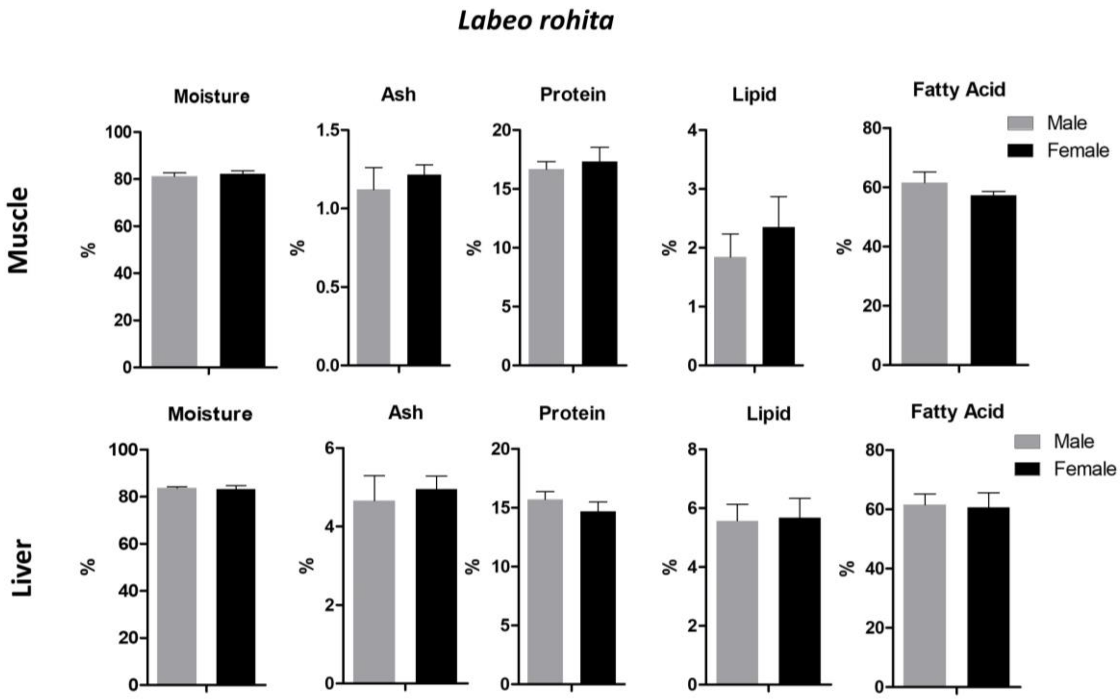

Figure 6. depicts the biochemical composition of *Labeo rohita* in the JLN canal, elucidating distinctive features of this fish's physiological makeup within the canal ecosystem.

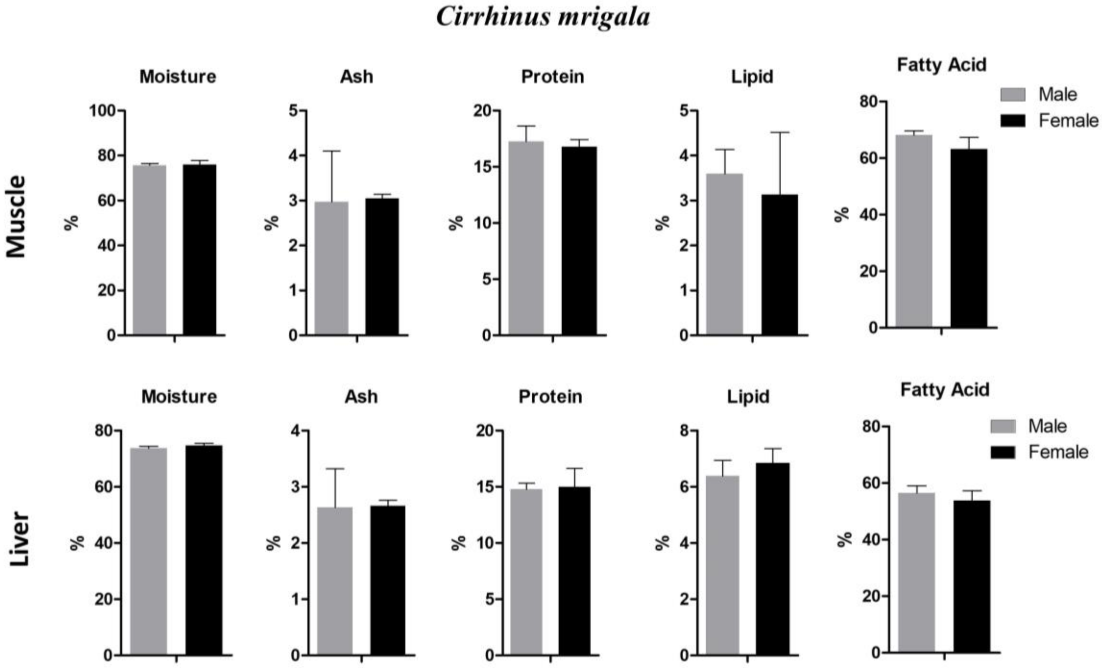

Figure 7. highlights the biochemical composition of *Cirrhinus mrigala* at the JLN canal, offering valuable insights into the unique biochemical profile of this fish species thriving in the canal environment.