Comprehensive Analysis on the Metabolic Activity of the Fresh Water Fishes such as *Labeo rohita and Catla catla*

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Publication Date: 2025/09/10

Abstract: Sustainable aquaculture has become increasingly important in meeting global food demands while minimizing environmental impact. Integrated farming systems, which combine multiple compatible species, offer a promising approach to achieve this goal by optimizing resource use and improving overall productivity. This study provides a comparative analysis of two major freshwater carps, *Labeo rohita* (Rohu) and *Catla catla* (Catla), within an integrated farming framework. The research evaluates their growth performance, feed conversion efficiency, and tolerance to varying stocking densities, which are critical parameters for sustainable culture practices. Rohu, with its omnivorous and herbivorous tendencies, efficiently converts plant-based feed and natural pond productivity into biomass, making it highly adaptable to polyculture systems. Catla, a surface-feeding species with a preference for protein-rich zooplankton, shows rapid growth under optimal feeding conditions but requires more space and water quality management to thrive. When cultured together, these species complement each other's ecological niches, ensuring more efficient feed utilization, reducing competition, and enhancing overall biomass production. The study highlights that integrating Rohu and Catla in aquaculture systems not only maximizes yield but also promotes ecological balance and resource sustainability, making it a viable strategy for long-term, environmentally responsible freshwater fish farming.

Keywords: *Alkalinity, Fertility of the Soil, Fresh Water Fish, Nitrogenous Waste.*

How to Cite: R. Akshitha; D. S. Hanshika Devi; M. G. Lekha; B. V. Sanjuktha; Santhana Lakshmi V.; Dr. D. P. Sivasakti Balan (2025) Comprehensive Analysis on the Metabolic Activity of the Fresh Water Fishes Such as *Labeo rohita* and *Catla catla*. *International Journal of Innovative Science and Research Technology*, 10(8), 2730-2735. https://doi.org/10.38124/ijisrt/25aug1002

I. INTRODUCTION

Integrated farming is an agricultural approach that combines two or more compatible farming activities—such as crop cultivation, livestock, fishery, or aquaculture—on the same piece of land or water body to maximize resource use, increase productivity, and ensure economic stability. The system is designed so that the by-products or waste from one component serve as inputs for another, creating a sustainable and eco-friendly cycle. For example, animal manure can be used to fertilize crops or fish ponds, while crop residues can feed livestock. Integrated farming reduces dependency on external inputs, minimizes environmental impact, and enhances overall farm income. This method is particularly important in regions with limited land and water resources, as it promotes efficient utilization of available resources while supporting food security and sustainable agriculture.

Sustainability refers to the ability to meet present human needs while ensuring that natural, social, and economic resources are maintained so that future generations can also meet their needs. It emphasizes a balance between environmental protection, economic development, and social well-being, ensuring that growth does not compromise ecological systems or community resilience. Ammonia and urea are two of the most widely used nitrogenous fertilizers in modern agriculture. Ammonia, usually applied in the form of anhydrous ammonia or ammonium salts, supplies plants with a

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1002

readily available source of nitrogen, which is essential for chlorophyll formation, protein synthesis, and overall plant growth. Urea, containing about 46% nitrogen, is the most concentrated solid nitrogen fertilizer and is highly soluble, making it effective for both soil and foliar applications. Its gradual hydrolysis in the soil releases ammonium carbonate, which provides a sustained nitrogen supply for crops. Together, these fertilizers play a critical role in improving crop yields and supporting global food production.

Soil alkalinity is a condition where the soil pH remains higher than neutral, often due to the accumulation of carbonates and bicarbonates of sodium, calcium, or magnesium. In such soils, nutrient availability is limited, particularly for nitrogen, phosphorus, and micronutrients like zinc and iron, which are vital for paddy (*Oryza sativa*) growth. As a result, rice plants grown in alkaline soils commonly exhibit symptoms such as poor germination, reduced tillering, yellowing of leaves, and low grain yield. Flooded conditions used in rice cultivation can partially alleviate alkalinity by dissolving and leaching salts, but long-term productivity requires soil amendments. The use of gypsum, organic manures, green manuring crops, and proper water management has been shown to improve soil properties and enhance rice growth in alkaline conditions.

➢ *Hypothesis*

Labeo rohita the fresh water fish which can provide required nutrient for the paddy field and maintain alkalinity of the soil. Labeo rohita can be the best at conversion ability salinity tolerance and crowd management ability compared to Catla catla

II. REVIEW OF LITERATURE

Nitrogenous waste excretion in fishes has been extensively studied due to its significance in aquaculture sustainability and water quality management. Most teleost fishes, including carps, excrete over 70–80% of their nitrogenous waste in the form of ammonia, which is mainly released across the gills, while a smaller proportion is excreted as urea or other compounds (Wright & Wood, 2009). The quantity and form of nitrogen excretion depend on dietary protein content, energy balance, and physiological traits of species. Research has shown that feeding strategies, such as herbivory in *Labeo rohita* and surface feeding behavior in *Catla catla*, may influence metabolic rates and nitrogen turnover, thereby affecting waste output (Jobling, 1994). Studies on carp metabolism emphasize that differences in feeding ecology lead to species-specific variations in nitrogen budgets within pond ecosystems.

In aquaculture systems, the nitrogenous waste produced by fish significantly impacts water quality by increasing levels of ammonia and other nitrogen compounds, which can stress or even kill cultured species if not managed properly. Das et al. (2005) demonstrated that nitrogen and phosphorus budgets in fertilized freshwater ponds are influenced by stocking density and the combination of rohu and catla, highlighting the importance of understanding species-specific waste production for sustainable culture practices. Similarly, Jena et al. (2002) reported that mixed-species culture of Indian major carps, including rohu and catla, can optimize resource utilization but also results in differential nutrient excretion patterns depending on biomass and feeding intensity. These findings suggest that analytical studies comparing nitrogenous waste between rohu and catla are essential for improving feed efficiency, minimizing environmental pollution, and enhancing aquaculture productivity.

➢ *Rule of Thumb (per m²):*

(Anhydrous ammonia is ~82% N by weight.

Typical rice (paddy) N recommendations commonly fall in the 70–200 kg N/ha range depending on variety, soil, and management (often split applications).

➢ *Converted to Ammonia (NH_3) per Square Meter:*

- 70 kg N/ha → ~8.54 g NH_3/m^2 (70×0.12195)(70 × 0.12195)(70×0.12195)
- 100 kg N/ha → ~12.20 g NH_3/m^2
- 120 kg N/ha → ~14.63 g NH_3/m^2
- 150 kg N/ha → ~18.29 g NH_3/m^2
- 200 kg N/ha → ~24.39 g NH_3/m^2

A water tank can act as a source of nutrients for soil depending on the quality and composition of the stored water. Irrigation water from tanks often carries dissolved minerals such as calcium, magnesium, and potassium, which are essential for plant growth. If the tank also collects organic matter, sediments, or supports fish culture, the water becomes enriched with nitrogen, phosphorus, and other nutrients released from waste and decomposition. When this nutrient-rich water is applied to fields, it not only irrigates the crop but also improves soil fertility. In contrast, pure rainwater stored in tanks generally has very low nutrient content and mainly serves as a water supply rather than a fertilizer source.

III. METHODOLOGY

Secondary data refers to information that has already been collected, processed, and made available by other researchers, organizations, or institutions for purposes different from the current study. Instead of generating new data, researchers rely on existing sources such as government reports, published articles, books, company records, online databases, or survey datasets. Secondary data is valuable because it saves time, reduces research costs, and provides access to large-scale or long-term information that might be difficult for an individual researcher to collect independently.Secondary data is collected for our study to find the suitable fish for integrated farming in paddy field Fresh water fishes like Rohu → *Labeo rohita*, Catla → *Catla catla*

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1002

Table 1 Comparitive Analysis on Properties of *Labeo rohita* and *Catla catla*

Feature	Rohu (*Labeo rohita*)	Catla (*Catla catla*)
Tolerance level	Moderate tolerance to water quality fluctuations; grows well in freshwater ponds and rivers	High tolerance to freshwater environments but sensitive to very low dissolved oxygen
Growth rate	Moderate to fast; reaches ~1–1.5 kg in 2 years under culture	Fast-growing; can reach 1.5–2.5 kg in 2 years under culture
Life span	Around 6–10 years in natural conditions	Around 8–12 years in natural conditions
Nutrient content (flesh)	Rich in protein (~17–20%), low fat, contains omega-3 fatty acids, vitamins, and minerals like phosphorus and calcium	High protein (~18–20%), slightly higher fat than rohu, good source of essential amino acids and minerals
Feeding pattern	Column feeder; mainly herbivorous, feeding on plant material, algae, and decaying vegetation	Surface feeder; mainly planktivorous, consuming zooplankton and phytoplankton

Metabolic activity includes the ability to convert food in to protein and life span. Fishes with higher tolerance and better conversion capacity are suitable for the economically efficient quality.

Table 2 Comparitive Analysis on Conversion Ability of *Labeo rohita* and *Catla catla*

Parameter	Rohu (*Labeo rohita*)	Catla (*Catla catla*)
Feed Conversion Ratio (FCR) (amount of feed required to produce 1 kg of fish)	~1.8 – 2.0 kg feed/kg fish	~1.5 – 1.8 kg feed/kg fish
Nitrogen excretion (as Ammonia-N)	~25–30% of feed nitrogen excreted; estimated **28–32 g NH_3-N per kg fish biomass gain**	~20–25% of feed nitrogen excreted; estimated **22–27 g NH_3-N per kg fish biomass gain**
Urea excretion	Very small fraction (<5% of total N excretion), usually **2–3 g urea-N per kg fish biomass gain**	Very small fraction (<5% of total N excretion), usually **1.5–2.5 g urea-N per kg fish biomass gain**
Waste impact	Moderate nitrogen loading in ponds; balanced in polyculture systems when combined with surface and bottom feeders	Slightly lower ammonia release compared to rohu due to higher feed efficiency; still contributes significantly to pond nitrogen load

Catla is more feed-efficient (lower FCR) compared to Rohu. Rohu tends to excrete slightly higher ammonia per kg biomass gain because of its column-feeding, herbivorous habit and moderate feed utilization efficiency.Both species excrete only a very small amount of nitrogen as urea, with ammonia being the dominant waste form.

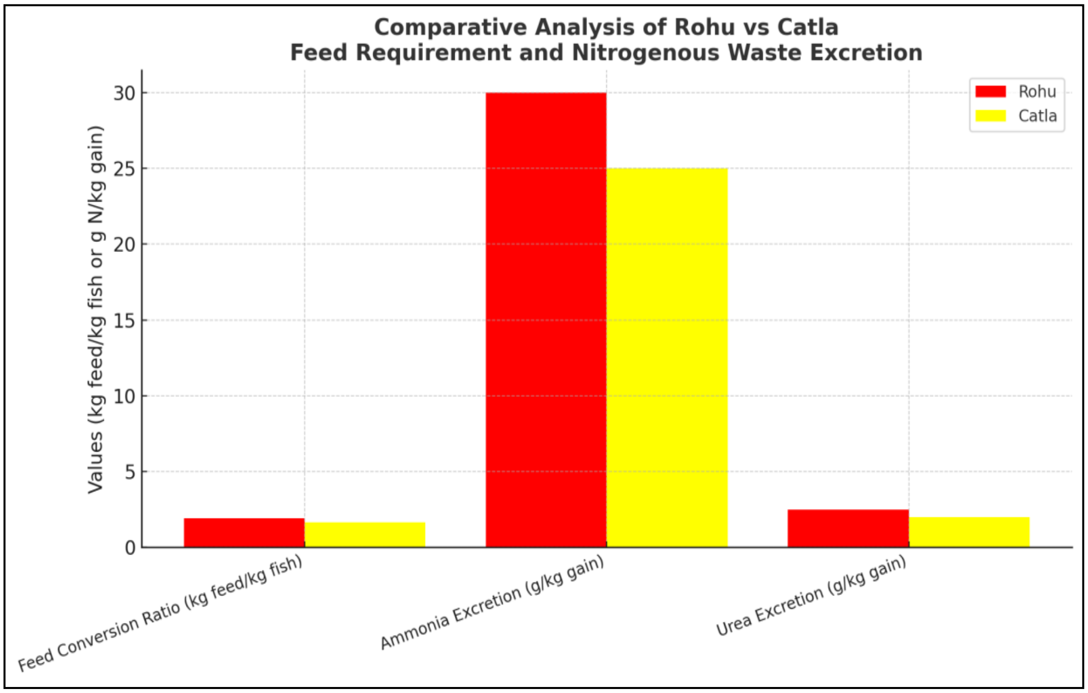

Fig 1 Comparitive Analysis on Conversion Ability of *Labeo rohita* and *Catla catla*

Table 3 Comparitive Analysis on Space Tolerance Capacity of *Labeo rohita* and *Catla catla*

Fish Species	Recommended Tank Density	Water Volume Needed per 1 kg Fish	Space Required (approx.)
Rohu (*Labeo rohita*)	~30–40 kg fish per m³ under intensive culture	~25–33 liters per 1 kg fish	~0.025–0.033 m³ per kg fish
Catla (*Catla catla*)	~25–35 kg fish per m³ under intensive culture	~28–40 liters per 1 kg fish	~0.028–0.040 m³ per kg fish

Rohu can be stocked at slightly higher densities than Catla due to its column-feeding behavior and adaptability. Catla, being a surface feeder and fast grower, generally needs slightly more space per kg fish to avoid stress and oxygen competition. FAO (2020). *Cultured Aquatic Species Information Programme – Rohu and Catla*. Food and Agriculture Organization of the United Nations.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug1002

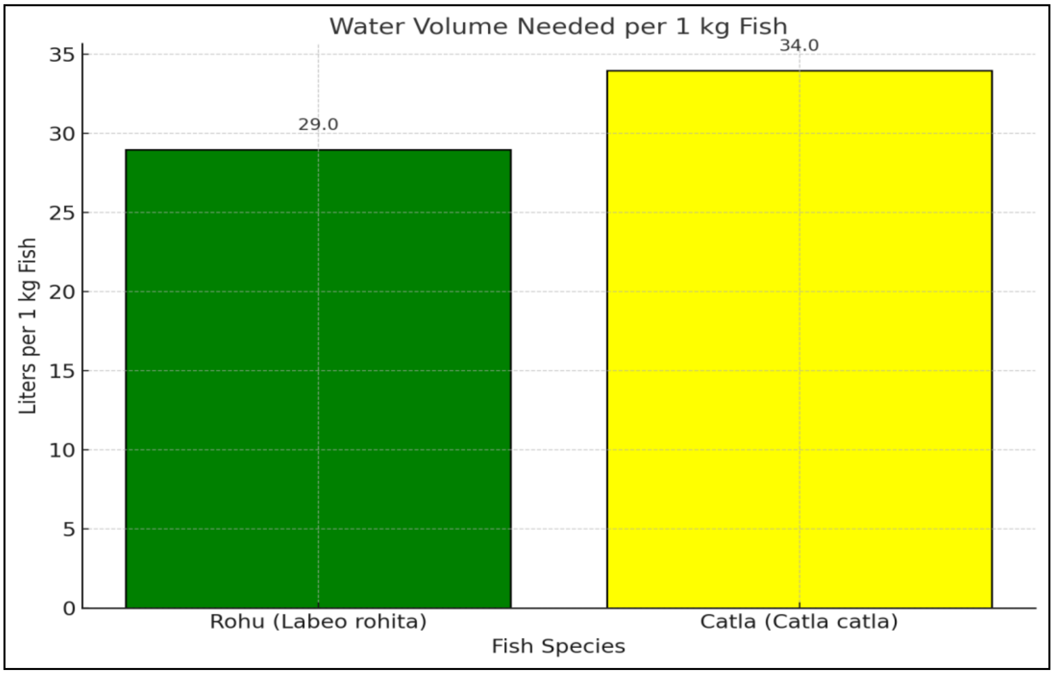

Fig 2 Comparitive Analysis on Crowd Tolerenceability of *Labeo rohita* and *Catla catla*

IV. RESULT AND DISCUSSION

Rohu (*Labeo rohita*) and Catla (*Catla catla*) are among the most commonly cultured freshwater carps in South Asia, known for their efficient feed conversion abilities. Both species can utilize natural food resources like phytoplankton, zooplankton, and detritus, while also responding well to supplementary feeding. Rohu, being more omnivorous with a tendency toward herbivory, converts plant-based feed into body mass effectively, making it suitable for polyculture systems. Catla, with its preference for zooplankton and surface feeding habit, shows good growth performance when protein-rich feed is available, though it is comparatively less efficient than rohu in converting plant material into biomass.

In terms of stocking density, these fishes exhibit notable adaptability, but their tolerance to crowding differs slightly. Rohu generally adapts better in higher densities due to its flexible feeding habits and efficient utilization of available feed and natural productivity. Catla, being a fast-growing surface feeder, requires more space and good water quality for optimal growth, and it may show stress or reduced feeding activity under very high densities. However, in well-managed ponds or tanks with proper aeration and water exchange, both species can sustain relatively high biomass without major adverse effects.

Overall, the conversion ability and crowd tolerance of rohu and catla make them suitable candidates for intensive and semi-intensive aquaculture. While rohu demonstrates more resilience under higher crowding and has a broader diet spectrum, catla contributes to faster biomass increase when given adequate protein-rich feed and sufficient space. Their complementary feeding habits are the reason they are often stocked together in polyculture, as this ensures efficient use of different ecological niches within the water body, thereby maximizing overall productivity.

Hypothesis accepted by analyzing results with the data.

V. CONCLUSION

In conclusion, Rohu and Catla are highly valuable for freshwater aquaculture due to their complementary feeding behaviors and efficient growth characteristics. Rohu's adaptability to higher stocking densities and ability to convert a wide range of feed, especially plant-based, into body mass makes it resilient in intensive culture systems. Catla, while requiring more space and protein-rich feed, grows rapidly and efficiently exploits surface-dwelling food resources. When cultured together, their differing feeding niches allow for optimal utilization of natural and supplementary feeds, enhancing overall pond productivity. Therefore, understanding their specific dietary preferences and density tolerances is key to designing sustainable and productive polyculture systems.

RECOMMENDATIONS

Based on the study we would propose the recommendation of growin fresh water crab and prawns as polyculture system.Cultivating crabs and prawns together in a polyculture system can improve overall yield and economic returns by taking advantage of their different feeding habits. Prawns, like *Macrobrachium rosenbergii*, mainly feed in the water column and require protein-rich diets for optimal growth, whereas crabs are bottom-dwellers that scavenge on leftover feed, detritus, and small organisms, helping to maintain water quality. Proper management, including moderate stocking densities, provision of hiding spaces for crabs, and regular monitoring of water conditions, is essential to reduce stress and prevent aggressive interactions. By occupying separate ecological niches, crabs and prawns minimize competition for food, maximize resource use, and support a balanced, sustainable, and productive aquaculture system.

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