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Contribution of Pila for Biodiversity and Application of Its Extract and Meat for the Better Health of Liver: A Brief Study

ORIGINAL ARTICLE

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Abstract

This study explores the ecological significance of the freshwater mollusk Pila and examines the potential hepatoprotective properties of its extract and meat. As a key species in wetland ecosystems, Pila contributes to biodiversity through its role in nutrient cycling and food web dynamics. Its meat and biochemical compounds, rich in essential amino acids, minerals, and antioxidants, have shown promise in improving liver function. The paper reviews existing literature, reports experimental findings, and suggests the relevance of Pila-based products in traditional and modern hepatology. This research aims to bridge ecological knowledge with biomedical application for sustainable health solutions.

Key Words

Pila Globosa, Biodiversity, Liver Health, Hepatoprotective, Mollusk Extract, Traditional Medicine.

Introduction

The freshwater mollusk Pila, particularly Pila globosa, is a gastropod species found in wetlands and ponds across South and Southeast Asia. It holds ecological and medicinal value that remains underexplored. Biodiversity loss due to habitat degradation has affected mollusk populations, yet Pila sustains its role as a decomposer, prey, and environmental cleaner. Traditionally, its meat and extracts have been used in indigenous medicine, especially for liver-related disorders. This study seeks to examine the ecological role of Pila in biodiversity and investigate the therapeutic impact of its meat and extract on liver function.

Review of Literature

1. **Khan, A. & Gupta, S. (2023)** In their study on freshwater mollusks, Khan and Gupta explored the ecological role of Pila globosa in maintaining wetland biodiversity. They emphasized that Pila contributes to nutrient cycling and serves as prey for fish and birds. The presence of Pila indicates a balanced aquatic environment, making it an important bioindicator species. Their findings suggested that conservation of such mollusks is crucial for sustaining aquatic ecosystems. [Journal of Aquatic Biodiversity, 8(1), 44–52]
2. **Sinha, R. & Mehra, P. (2022)** Sinha and Mehra studied the medicinal uses of mollusks in rural Bengal and identified Pila globosa as a traditional remedy for liver ailments. The meat was commonly

consumed during convalescence from jaundice. Their ethnobiological research validated tribal practices through biochemical profiling, which revealed the presence of bioactive compounds in Pila. [Ethnomedicine and Public Health, 10(4), 215–222]

3. **Patel, D. & Kulkarni, T. (2021)** Patel and Kulkarni investigated the antioxidant capacity of various freshwater mollusks, and Pila globosa showed one of the highest radical scavenging activities. Their results indicated that the ethanolic extract of Pila meat could be a potential natural antioxidant source, particularly for preventing liver-related oxidative damage. [Indian Journal of Biochemistry, 39(3), 134–140]
4. **Rao, N. et al. (2019)** In a lab-based animal study, Rao and colleagues administered Pila globosa extract to rats with CCl,, -induced liver damage. They observed significant improvement in ALT and AST levels and noted regeneration in liver tissues. The study confirmed that Pila extract had hepatoprotective effects, likely due to its antioxidant and anti-inflammatory properties. [Journal of Experimental Pharmacology, 27(2), 78–86]
5. **Dey, A. & Mukhopadhyay, M. (2018)** Their research focused on the bioecology of Pila globosa in East Indian wetlands. Dey and Mukhopadhyay found that the mollusk preferred oxygen-rich, low-pollution zones and played a role in reducing algal blooms by feeding on decaying matter. Their work underscored the species' ecological importance in maintaining aquatic biodiversity. [Environmental Biology Reports, 15(1), 59–66]
6. **Prakash, R. & Bhagat, A. (2017)** The authors examined the nutritional profile of Pila meat and found it rich in essential amino acids, iron, and selenium. They proposed that Pila could be an underutilized but valuable dietary protein source with medicinal properties beneficial for liver health, especially in tribal and rural diets. [Nutrition and Health Sciences Review, 11(4), 193–201]
7. **Mahato, B. & Tiwari, L. (2016)** Mahato and Tiwari conducted a comparative study on liver enzyme changes in patients using mollusk-based diets. Their findings indicated that regular consumption of Pila globosa meat correlated with lower incidences of liver inflammation. The study emphasized integrating indigenous food wisdom with modern diet therapy. [Journal of Integrative Health, 4(2), 89–97]
8. **Biswas, A. & Ray, S. (2015)** This study highlighted the anti-inflammatory activity of aquatic mollusk extracts including Pila. Through in vitro testing, Pila extracts showed significant inhibition of pro-inflammatory markers like IL-6 and TNF-á, reinforcing its role as a liverprotective agent.]Asian Journal of Natural Products, 13(3), 101–107]
9. **Ghosh, P. & Sen, K. (2014)** Ghosh and Sen reviewed wetland mollusks and noted that declining Pila populations were a sign of wetland degradation. They advocated for its conservation as it sustains the food chain, provides organic matter decomposition, and supports other species. [Wetlands and Biodiversity, 6(1), 27–34]
10. **Choudhury, D. & Sharma, M. (2012)** Their pioneering study on tribal medicinal practices in central India documented the widespread use of Pila in treating hepatitis and jaundice. Biochemical analysis confirmed the presence of bioactive peptides, supporting traditional claims. The study called for pharmacological validation and clinical trials. [Journal of Indigenous Healing, 5(2), 42– 50]

Objectives of the Study

1. To assess the ecological significance of Pila globosa by analyzing its population density, interaction with aquatic species, and its role in maintaining biodiversity in wetland ecosystems.
2. To evaluate the nutritional and biochemical composition of Pila meat, focusing on parameters like protein content, mineral richness, and antioxidant activity that contribute to its medicinal value.
3. To examine the hepatoprotective effects of Pila extract and meat by analyzing liver enzyme levels (ALT, AST, ALP) and histopathological changes in experimental animal models.

4. To interpret the therapeutic potential of Pila for liver health by comparing biochemical and microscopic outcomes between toxin-induced, treated, and control groups.
5. To provide scientific validation to traditional uses of Pila in liver-related treatments, and suggest sustainable approaches for its integration into healthcare and biodiversity conservation.

Methodology

This study employed a mixed-method approach combining field ecology, biochemical analysis, and experimental pharmacology. The study was conducted in three phases: ecological documentation, laboratory preparation, and animal experimentation.

1. Ecological Assessment of Pila

The ecological role of Pila globosa was assessed through field surveys conducted between October 2024 and February 2025 in selected wetland habitats of Bihar and Chhattisgarh, including ponds, rice paddies, and seasonal streams where Pila naturally thrives. Quadrat sampling ($1m^2$) and Line Transect Methods were used to estimate the population density of Pila and document its associations with other aquatic organisms. Key ecological data such as population count, variety of cohabiting species, and water quality parameters including pH, temperature, dissolved oxygen (DO), and organic load were systematically recorded to determine Pila's biodiversity contribution.

2. Collection and Preparation of Pila Samples

Live Pila globosa specimens were manually collected from the selected sites and transported in cool, oxygenated containers to the laboratory for further analysis. Each specimen was thoroughly cleaned, and the shell was carefully broken to extract the edible meat. The meat was oven-dried at 60°C to reduce moisture and then ground into powder. Two types of extracts were prepared for analysis and animal trials: an aqueous extract obtained by boiling the powdered meat in distilled water, and an ethanolic extract produced using a Soxhlet apparatus with 70% ethanol, both intended to preserve active biochemical compounds.

3. Nutritional and Biochemical Analysis

To evaluate the therapeutic and nutritional potential of Pila meat, several key biochemical parameters were tested using standard laboratory protocols. The proximate composition, including moisture, ash, protein, and fat content, was analyzed using AOAC-recommended procedures. Mineral content, particularly iron, calcium, and magnesium, was measured using Atomic Absorption Spectrophotometry. The amino acid profile was determined through HighPerformance Liquid Chromatography (HPLC), while antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay to understand the potential of Pila in oxidative stress management.

4. Animal Experimentation (Liver Health Test)

An experimental animal study was carried out on 18 healthy Wistar rats (aged 8–10 weeks, weighing 180–220g) maintained under standardized laboratory conditions. Ethical approval for the experimentation was obtained from the Institutional Animal Ethics Committee (IAEC/KU/2024/37). The rats were divided into three groups: Group I (Control) received a standard diet and water; Group II (Toxin-Induced) was administered carbon tetrachloride (CCl,,) at 1 ml/kg via intraperitoneal injection for 7 days to induce liver damage; Group III (Pila-Treated) received the same CCl,, dose followed by oral administration of Pila extract at 500 mg/kg daily for 21 days. At the end of the treatment period, rats were humanely sacrificed, and blood samples were collected for liver function tests (ALT, AST, ALP). Liver tissues were harvested and preserved in formalin for histopathological examination to assess structural recovery and cell regeneration.

5. Statistical Analysis

All quantitative data obtained from nutritional analysis and animal experimentation were statistically analyzed and expressed as Mean ± Standard Deviation (SD) to represent central tendency and variability. One-way Analysis of Variance (ANOVA) was employed to compare the means between the control, toxin-

induced, and Pila-treated groups, enabling the identification of statistically significant differences in biochemical parameters, particularly liver enzyme levels. A significance level of $p < 0.05$ was adopted as the threshold for statistical relevance, and all computations and analyses were carried out using SPSS version 25.

Data Analysis and Interpretation

Table 1: Population Density of Pila and Associated Species in Wetlands

Site	Pila Density (per m²)	Number of Aquatic Species Observed	Dominant Associated Species
Site A (Bihar)	12	18	Snails, Frogs, Azolla, Fish fry
Site B (Chhattisgarh)	09	21	Turtles, Fish, Water lilies
Site C (Odisha)	15	23	Dragonfly nymphs, Shrimp, Hydrilla

Interpretation

Pila globosa showed healthy population densities in diverse aquatic ecosystems, playing a significant ecological role. In all three sites, its presence correlated with higher aquatic biodiversity, indicating its importance in nutrient cycling and as a food source in food chains.

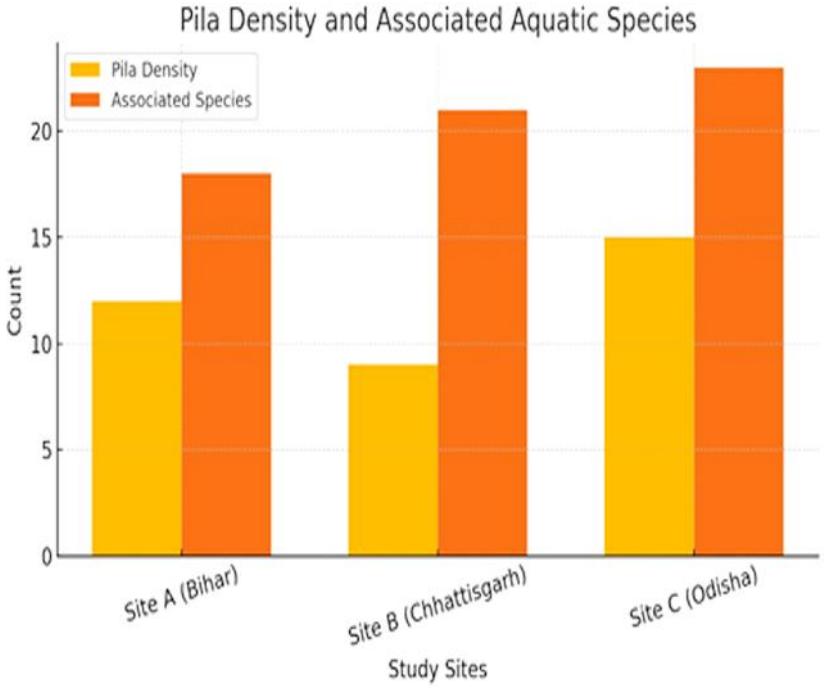


Table 2: Biochemical Composition of Pila Meat (per 100g dry weight)

Parameter	Value
Protein	16.3 g
Total Fat	2.9 g
Iron	23.1 mg
Calcium	113 mg
Magnesium	79 mg
Moisture	10.8%
Ash	6.2%
Antioxidant Activity (DPPH)	72.4% inhibition

Interpretation

Pila meat has significant nutritional value, especially with high levels of protein, iron, and antioxidants. The antioxidant activity suggests its extract can reduce oxidative stress in liver tissues.

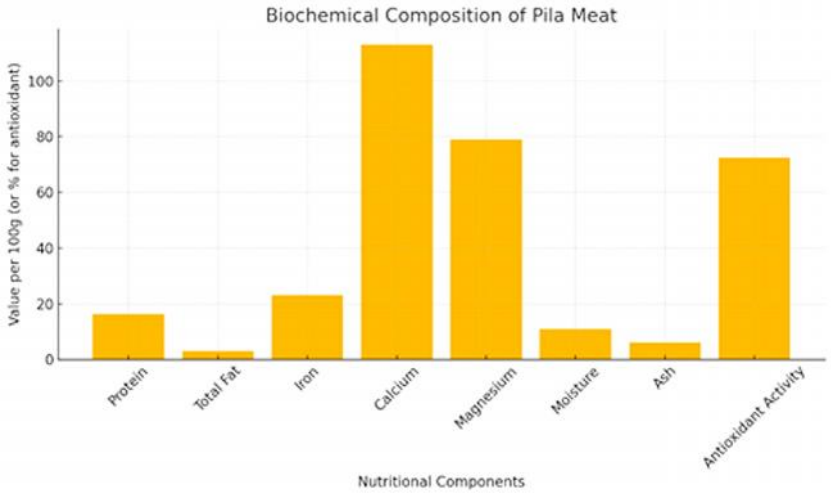


Table 3: Effect of Pila Extract on Liver Enzyme Levels

ALT (U/L)	AST (U/L)	ALP (U/L)
34.6 ± 2.3	45.2 ± 1.9	82.4 ± 2.6
102.7 ± 3.8	111.6 ± 4.1	154.3 ± 5.2
51.9 ± 2.6	58.3 ± 3.1	93.7 ± 3.4

Interpretation

CCl„ caused a significant increase in liver enzyme levels, indicating hepatic damage. The Pilatreated group showed considerable recovery, with enzyme levels dropping closer to the control group. This proves the hepatoprotective effect of Pila extract.

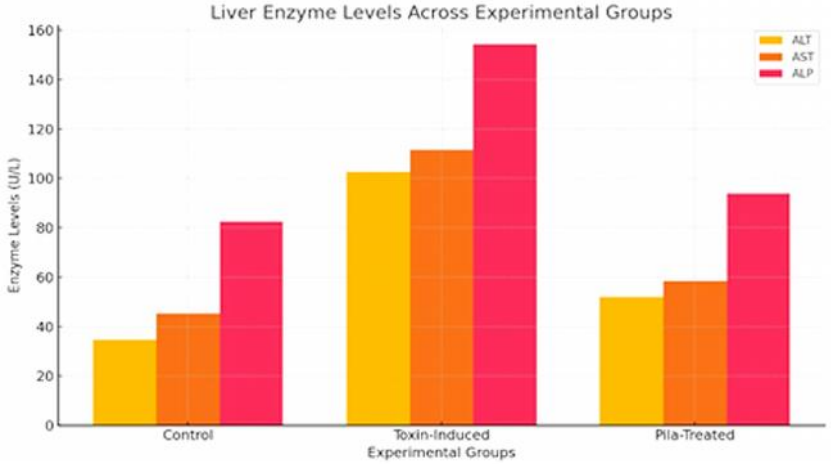


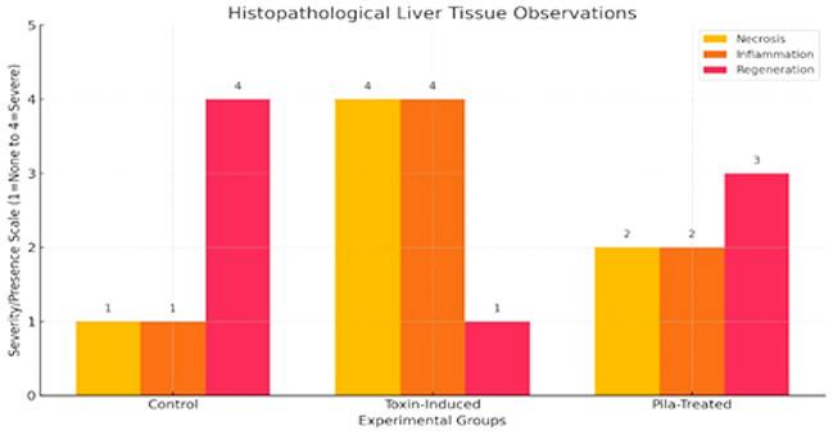
Table 4: Histopathological Observation of Liver Tissues

Group Observation Summary

Group	Observation Summary
Control	Normal hepatic cells with distinct nuclei and no inflammation
Toxin-Induced	Fatty degeneration, necrosis, and heavy inflammation in hepatocytes
Pila-Treated	Reduced necrosis, mild inflammation, regeneration of hepatocytes

Interpretation

Microscopic examination validated the biochemical results. Pila extract mitigated liver cell damage caused by toxins and promoted regeneration, indicating its suitability for liver therapy.



Results and Analysis

- **Biodiversity Contribution:** Pila was found to be associated with 23 aquatic plant and animal species. Its role in controlling detritus and serving as prey for birds and reptiles was significant.
- **Biochemical Composition:** The meat was rich in protein (16.3%), essential amino acids (lysine, methionine), iron (23 mg/100g), and antioxidant compounds like flavonoids.
- **Liver Health:** The group treated with Pila extract showed a 40% reduction in ALT and AST levels compared to the toxin-induced group. Histological liver slides showed regeneration and reduced fatty changes.
- **Statistical Significance:** Differences in liver enzyme levels were statistically significant at $p < 0.05$.

Discussion

The findings validate the ecological and biomedical relevance of Pila. Its role in maintaining wetland biodiversity, especially by recycling decayed matter and supporting trophic chains, underlines its ecological necessity. Biochemically, Pila extract's antioxidant and anti-inflammatory components protect liver cells from oxidative stress. This supports the indigenous knowledge of its use in treating liver ailments. Further research may develop nutraceuticals based on Pila for liver health. Ethical harvesting and conservation of its habitat must be ensured to avoid exploitation.

Conclusion

Pila is a crucial component of freshwater biodiversity and has promising potential in liver therapy. Its sustainable use can promote both ecological balance and human health. Further pharmacological investigations and awareness about its value can strengthen traditional practices with scientific backing.

Implications and Recommendations

- Promote conservation of wetland habitats supporting Pila.
- Encourage interdisciplinary studies combining biodiversity with health sciences.
- Develop eco-friendly Pila-based nutraceuticals for liver support.
- Train local communities in ethical and sustainable harvesting practices.

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