Bioenergetics of *Ompok pabda* During Summer and Winter Across Life Stages in the Climatic Conditions of Tripura, India.

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Abstract

The bioenergetics of *Ompok pabda* varies significantly across seasons due to environmental factors such as temperature and humidity. This study examines seasonal variations in energy allocation among different life stages—fingerlings, pre-adults, adult males, and adult females—under controlled aquaculture conditions mimicking the natural climate of Tripura, India. The ingestion rate, assimilation efficiency, metabolic maintenance, growth rate, and energy used for reproduction were assessed during summer (28–32°C, 70–90% humidity) and winter (16–20°C, 50–60% humidity). Results indicated that metabolic rates and energy allocation for growth were higher in summer, while winter led to reduced ingestion, lower assimilation efficiency, and decreased growth. Graphical analysis of ingestion rate vs. assimilation efficiency and energy partitioning across seasons revealed significant seasonal influences on bioenergetics. These findings have implications for optimizing aquaculture strategies for *Ompok pabda* in fluctuating climatic conditions.

Keywords

Ompok pabda, Bioenergetics, Seasonal Variation, Growth, Energy Allocation, Metabolism, Tripura

Introduction

The growth, metabolism, and reproduction of *Ompok pabda*, a commercially significant catfish species, are strongly influenced by seasonal variations in temperature and humidity (Saha & Banerjee, 2018). As an ectothermic species, its bioenergetic processes fluctuate between summer and winter due to changes in ingestion rates, metabolic activity, and energy allocation (Jha & Singh, 2019). Understanding these variations is crucial for sustainable aquaculture management in regions such as Tripura, where environmental conditions shift considerably between seasons. This study evaluates the seasonal differences in the bioenergetics of *Ompok pabda* at different life stages to determine optimal feeding strategies for enhanced growth and reproduction.

Materials and Methods

Study Area and Environmental Conditions: The study was conducted in controlled aquaculture conditions simulating natural variations observed in **Tripura, India**. The environmental parameters were maintained within the following ranges:

- **Summer:** Temperature **28–32°C**, Humidity **70–90%**
- **Winter:** Temperature **16–20°C**, Humidity **50–60%**

Water parameters such as **pH (6.8–7.5), dissolved oxygen (5–7 mg/L), and ammonia (<0.02 mg/L)** were maintained at optimal levels.

Experimental Setup

Fish were reared in controlled tanks with natural and formulated feed. The study considered four life stages:

1. **Fingerlings:** (1.9–3.3 cm, 0.7–1.1 g)
2. **Pre-adults:** (10–13.6 cm, 6.9–9.4 g)
3. **Adult Males:** (14–18.6 cm, 14.4–20.7 g)
4. **Adult Females:** (15–18.6 cm, 20.8–45 g)

Each group was acclimatized for **two weeks** before the 30-day experimental trials.

Feeding and Growth Monitoring

- Fish were fed **formulated feed (35% protein) and live feed (zooplankton, crustaceans)** in a **2.5% body weight ratio** per day.
- **Length and weight measurements** were taken weekly.

Energy Budget Estimation

The bioenergetic components were calculated using the equation:

$I=A+M+G+RI=A+M+G+R$

where:

- **Ingestion (I):** Total food intake (kcal/day)
- **Assimilation (A):** Energy absorbed from food
- **Metabolism (M):** Energy used for maintenance
- **Growth (G):** Energy for somatic development
- **Reproduction (R):** Energy allocated to gonadal development (only in adults)

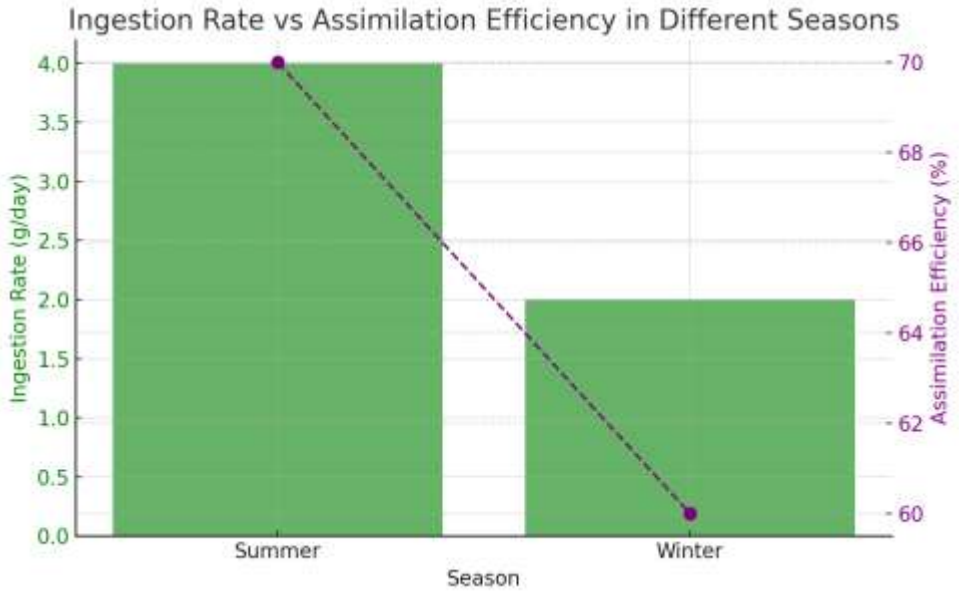
Data Collection and Statistical Analysis

- **Ingestion rate and assimilation efficiency** were recorded.
- **Metabolic energy expenditure** was estimated using oxygen consumption studies.
- **Statistical analysis** was performed using **ANOVA ($p < 0.05$)** to compare seasonal variations.

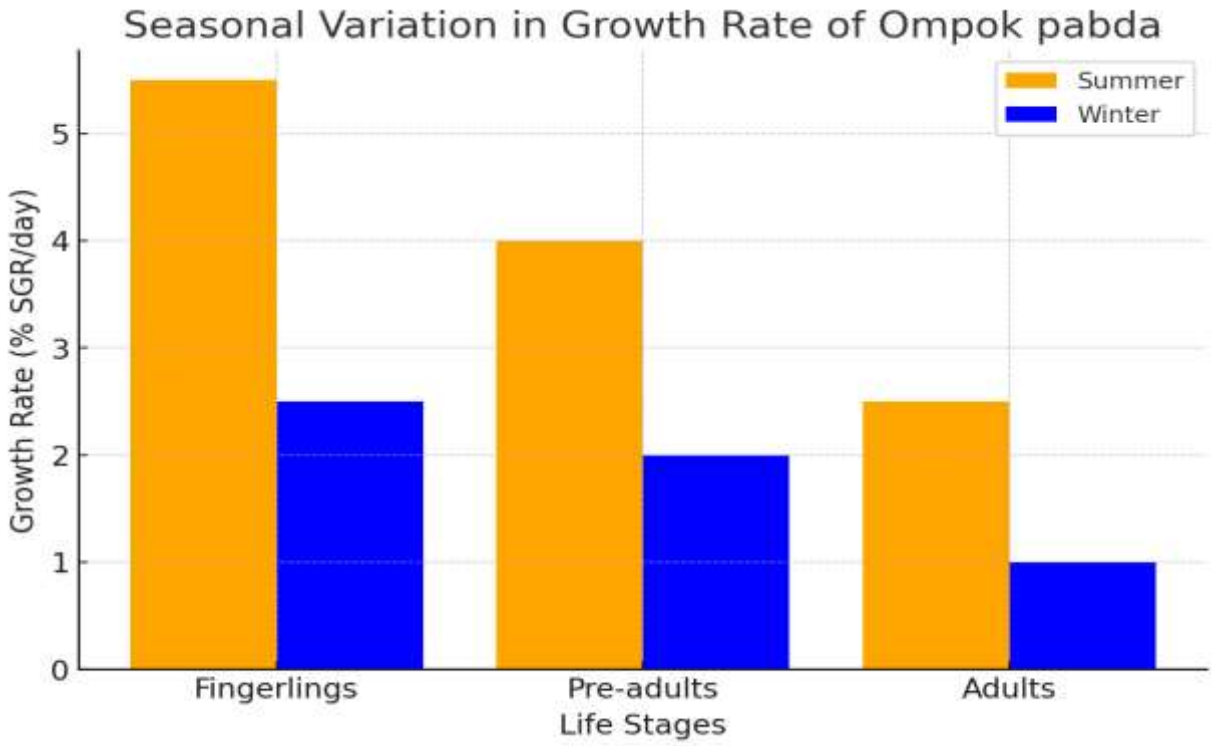
Results and Discussion

Seasonal Variations in Bioenergetics

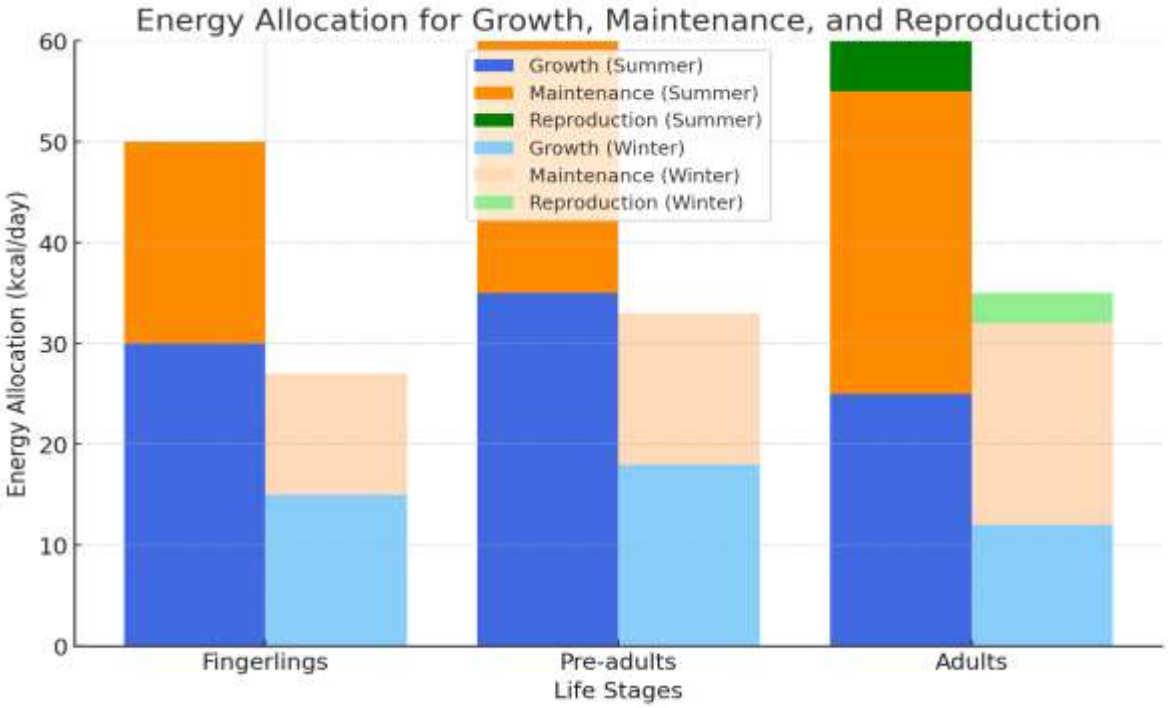
Parameter	Summer	Winter
Temperature (°C)	28–32	16–20
Humidity (%)	70–90	50–60
Ingestion Rate (g/day)	Higher (1.5–5.0 g)	Lower (1.0–3.0 g)
Assimilation Efficiency (%)	60–75	55–70
Growth Rate (SGR %/day)	3–6	1–3
Maintenance Energy (kcal/day)	15–25	10–18
Energy for Growth (kcal/day)	20–35	10–15
Energy for Reproduction (kcal/day)	5–15 (only in adults)	0–5 (minimal)



Graph 1: Overall rate of ingestion vs assimilation efficiency in different seasons.



Graph 2 : Growth rate in different stages in Summer and Winter.



Graph3: Energy allocation for growth, maintenance and reproduction in different stages .

Discussion

The **higher ingestion rate and assimilation efficiency in summer** correlated with increased metabolic activity and growth. In contrast, **lower winter temperatures reduced food intake, slowing metabolism and growth** (Bhatnagar & Kaur, 2017). **Energy allocation shifted towards maintenance in winter**, while **growth and reproduction peaked during summer**, confirming the importance of temperature in regulating fish bioenergetics. These findings align with previous studies indicating that metabolic activity in *Ompok pabda* is temperature-dependent, influencing aquaculture productivity.

Conclusion

This study highlights the significant impact of seasonal variations on the bioenergetics of *Ompok pabda* in Tripura's climate. **Warmer temperatures promoted higher ingestion rates, faster growth, and increased reproduction energy allocation, while colder temperatures reduced metabolic activity.** To enhance aquaculture efficiency, **temperature regulation and strategic seasonal feeding adjustments** are essential. These findings provide a foundation for optimizing the commercial production of *Ompok pabda* in controlled environments.

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