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Growth Performance of *Ompok pabda* (Hamilton, 1822), the Near Threatened Fish Species Reared in Recirculatory Aquaculture System

Running Title: An Innovative Technology of Rearing Fish

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Abstract The catfish *Ompok pabda* is a small indigenous freshwater fish commonly found in natural water bodies of Northeast India. Over the past years, the species has undergone significant decline due to over exploitation and hence placed in Near Threatened category by IUCN (version 2021-3). Therefore, need arises for providing proper growth condition for this fish species. For conservation purpose, this fish species was reared in Recirculatory Aquaculture System (RAS) in three individual tanks and its length weight relationships were derived for assessing its growth conditions. RAS technology is based on the principle of rearing fish at high densities, in indoor tanks with a "controlled" environment by filtering and cleaning the water for recycling it back through fish culture tanks. The value of 'b' recorded in the fish species using RAS technology ranged from 2.78 (r^2=0.822) to 2.91 (r^2=0.90) respectively which was higher than that of the fish species reared in pond ranging from b=2.49 (r^2=0.8335) to b=2.61 (r^2=0.84). Zero mortality was observed during the entire study. The current study has provided the evidence of improved growth condition and hence improved growth using RAS technology in comparison to pond culture which recorded slow growth rate. Therefore if such a system like RAS can be provided for rearing this fish species without any observed mortality, then this Near Threatened fish species can be easily captivated.

Keywords *Ompok pabda*, Recirculatory Aquaculture System

1. Introduction

Aquaculture has evolved from small-scale commerce to farming at a large-scale capacity over the past years. The aquaculture industry has been challenged to develop an economically viable system that not only produces species at high density but also faces some limitations arising out of location, water availability and environmental impacts [1]. By the application of Recirculating aquaculture system (RAS) technology, these limitations can be overcome which could provide sustainable farming of freshwater fish. Generally fish are grown outdoors in open ponds and raceways, but the RAS technology is based on the principle of rearing fish at high densities, in indoor tanks with a "controlled" environment by filtering and cleaning the water for recycling it back through fish culture tanks. New water is added to the tanks only when the necessity arises for removing waste materials. Fish that are grown in RAS technology need a continuous supply of clean water as well

as the temperature and dissolved oxygen content provided must be optimum for their growth. Sufficient oxygen supply helps to sustain healthy population of the fish as well as for the growth of the bacterial populations. Low oxygen levels decrease the growth of the fish, decrease in feed conversion rates, and as a result overall decline in fish production. Providing a suitable filter system helps in purifying the water and removing the harmful waste products and unused feed. RAS can be used to rear all types of species of fish, freshwater or marine or other aquatic animal, but usually high value species with a high growth rate are preferred. During the study, a highly valuable fish species known as *Ompok pabda* was reared using RAS technology to check its growth performance as well as to test its survivability using this technology against the wild species which have been reported to be in continuous decline by IUCN Red List [2].

The catfish *Ompok pabda* [3] also known as pabda or butter catfish is a small indigenous freshwater fish commonly found in natural water bodies of Northeast India. Although the fish is a good candidate species for aquaculture, the species has undergone significant decline due to over exploitation and hence placed in endangered category [4,5,6,7,8,9] and in Near Threatened category by IUCN [2]. This fish species has been successfully bred but larval survival was very poor [10, 11, 12, 13]. With an aim to maximise its survival rate, this fish species was reared in RAS and its length weight relationships were derived for assessing its growth conditions. The increase in length and the corresponding weight helps in providing sufficient information on the growth of a fish. During the growth of an organism, both length and weight increases simultaneously as both of them are positively correlated with each other. Study of length-weight relationship has good significance in fishery science since it acts as an important parameter for assessing growth rate, general well-being, appearance of first maturity, onset of spawning, status of stock variation etc. of fishes [14].

2. Materials and Methods

2.1. Fish Collection and Identification

Collection of fish was done during the month of October, 2023 with the help of cast-nets and local fishing methods from Garanga Beel, Morigaon, Assam with GPS coordinates 26.215583° N, 92.046027° E. A total of 2150 specimens measuring 5–5.1 cm in length and 1.1–1.2 gm in weight were collected and was brought to Dhakuakhana College Campus situated in Assam, India in oxygen-sealed poly bags with minimal stress. Identification was done following Talwar and Jhingran [15] and Jayaram [16]. The length (cm) and weight (g) of the sampled specimens of different length groups were then recorded. Fish were reared for a period of 5 months and length weight data was again recorded after 5 months.

2.2. Feeding of Fish

Pellet feed of size 2mm which was procured from the market was fed to the fish daily in the morning hours between 10–11 am at the rate of 2–3% of the body weight of the fish. Pelleted feed of size 2 mm was fed to the fish from the beginning. The percentage of composition present in the pelleted feed is presented in Table 1. During feeding both the filters in the RAS unit were shut down and were again resumed exactly 2 hours after feeding.

Table 1. Composition of nutrients in the feed fed to *Ompok pabda*

Nutrients	Composition (%)
Crude protein (Min)	32
Crude fat (Min)	4
Crude fibre (Max)	6
Total ash (Max)	12
Moisture (Max)	11

2.3. Recirculatory Aquaculture System Specifications

The structure of the tank for rearing the fish were of dimension 6 m in diameter and 2 m in height having a capacity of 30,000 liters and a maximum stocking density of 8 kg/m^3. The base was sloped with an angle of 18° so as to accumulate the waste at a particular pit from where the waste could be discharged easily. Aeration facility for bottom aeration and water circulation was provided by means of Venturi aeration system (Model: PAMBA PUZHA+/2020) of speed 2700 RPM and overall efficiency of 28%. This pump was placed 1.5 m below water level which created circular motion of water and this helped to accumulate solid waste at the centre. Both mechanical and biological systems were provided for highly controlling the ammonia level. Hi-Blow diaphragm air pump (Model HAP-120; Air flow rate: 120L/min) was provided for high supply of oxygen for the fish as well as for the bacterial colonies. Nitrifying bacteria *Nitrosomonas*, *Nitrospira* (Beta-ammonia oxidizers), and *Nitrobacter* (Nitrite oxidizers) were used for the study and were activated 10 days before inserting the fish in the tank. Drainage was provided by means of a discharge pipe which was opened at a month's interval time. An additional slurry pump was provided (TYPE SP-05M; Speed 2700 RPM; overall efficiency 31%) which pumps periodically the slurry of the fish and this slurry was used for vegetable cultivation. This pump was allowed to run at an interval of 3 days. Three individual RAS tanks were taken into consideration during the study period. No government agencies were involved in funding for the construction of the tanks.

Table 2. Water parameters recorded for a period of 5 months in RAS tank and in pond culture

	Temperature (°C)	pH	Conductivity (µS/cm)	Dissolved oxygen (mg/l)	Ammonia	Total Dissolved Solids (ppm)	Total Alkalinity (mg/l)	Nitrite (mg/l)
RAS unit 1	24.0° C ±1.2	7.5 ±0.75	171 ±2.1	7.2 ±0.25	<1	85 ±3.5	98.7 ±1.6	<1
RAS unit 2	24.2° C ±1.1	7.5 ±0.77	165 ±3.4	7.1 ±0.19	<1	81 ±2.3	88.0 ±1.4	<1
RAS unit 3	23.9° C ±1.4	7.4 ±0.94	166 ±2.4	7.1 ±0.22	<1	84 ±4.2	101.2 ±3.6	<1
Pond culture 1	23.7° C ±1.8	7.2 ±0.65	211 ±3.5	7.4 ±0.19	<1	102 ±3.5	109 ±1.2	<1
Pond culture 2	23.5° C ±1.4	7.2 ±0.41	222 ±4.1	7.5 ±0.55	<1	111 ±2.9	121.4 ±2.1	<1
Pond culture 3	23.2° C ±1.5	7.1 ±0.67	217 ±3.8	7.4 ±0.20	<1	108 ±2.35	115 ±1.85	<1

2.4. Water Parameters

Free, dechlorinated and well aerated water was used for the management of fish in RAS. All the water parameters like Temperature, pH, Conductivity, D.O., Hardness, Total alkalinity, ammonia level were regularly monitored using YSI Pro DSS Multiparameter water quality meter. 75% water was flushed out in a monthly interval time while the slurry was discharged regularly within 3 days interval time with the help of slurry pump. Water parameters recorded during the study period are being depicted in Table 2. Continuous aeration was provided with the help of aerator pump.

2.5. Growth Parameters

The length weight relationship was estimated following Le Cren [14] method:

$$W=a\ L^{b}$$

where, W= weight of the fish in gram, L= length of the fish in cm and ‘a’ and ‘b’ are constant. The equation has been transformed into the following logarithmic form:

$$\text{Log } W = \log a + b \log L$$

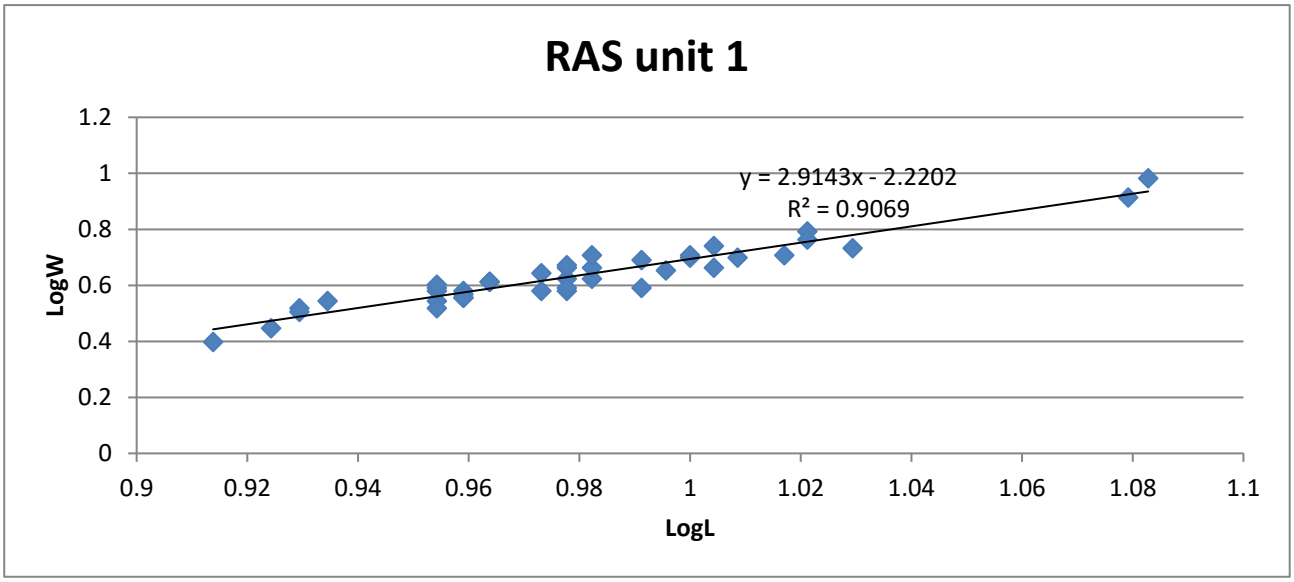
the values of ‘a’ and ‘b’ were determined empirically. Condition factor (K) was calculated by the equation:

$$K=100 \times W/L^{3}$$

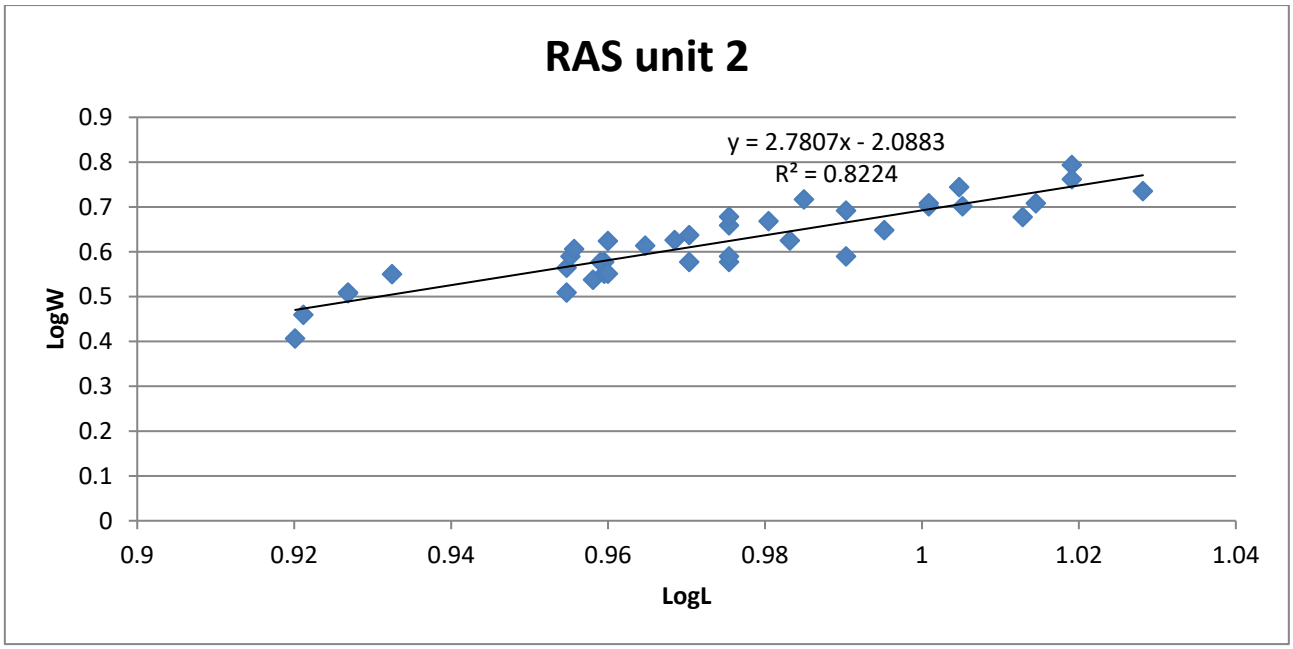
Where, ‘W’ is the weight (g) of the fish; ‘L’ is its total length (cm).

3. Results

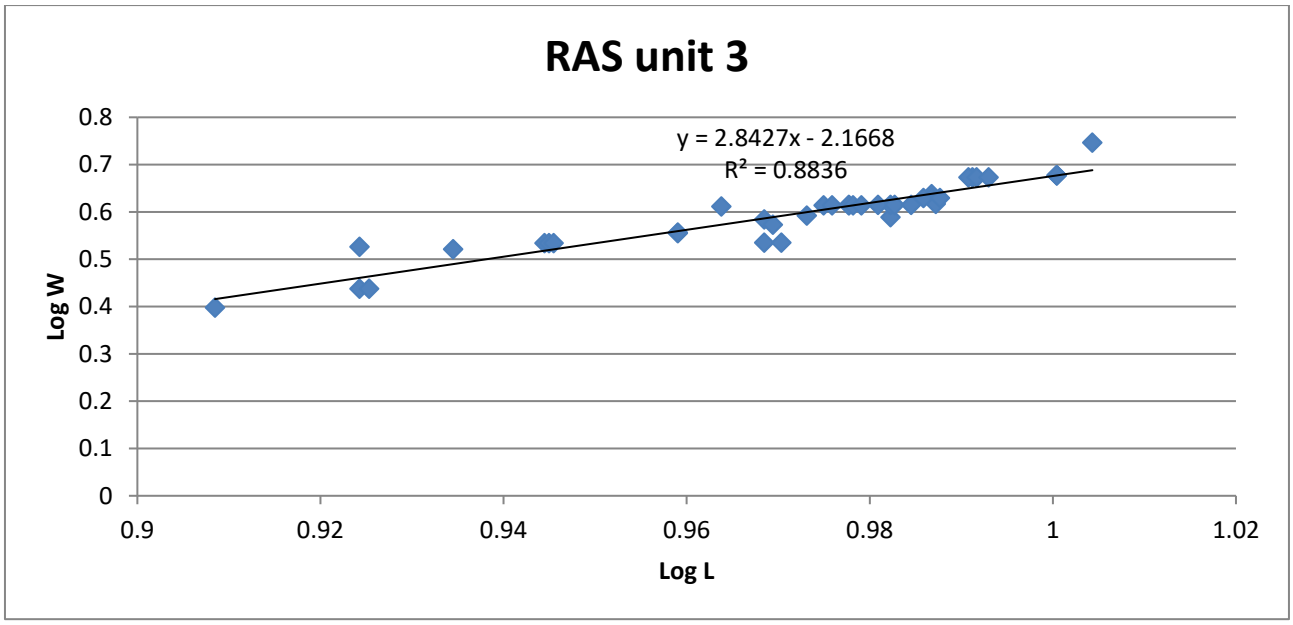
A total of N=150 fishes were randomly taken out from each individual RAS units and the same quantity of fish were taken out from three individual pond culture units which were taken into examination during this study. The present investigation revealed the size of the fish in the RAS tanks to be ranging from 8.2 cm to 12.1 cm in length whereas in the pond culture units fish ranged from a length of 8 cm to 10.21 cm. Difference in weight was observed to be between the range of 2.5 g to 6.1 g in the RAS units whereas it ranged between 2.6 g to 5.1 g in the pond culture units. To find out the relationship between length and weight, a logarithmic graph was plotted as depicted by Figure I with log L along the X-axis and log W along the Y-axis. The value of ‘b’ recorded from the graphs in the RAS units ranged between 2.78 to 2.91 which was higher than the value of b recorded from the fish cultured in pond which ranged between 2.49 to 2.77. Statistical analysis of Length Weight relationship parameters including the intercept (a) and slope (b) along with their 95% confidence limits are presented in Table 3. Condition factor was calculated for the tanks and ponds which recorded higher value in tanks (upto 1.0032) compared to the ponds (upto 1.0023). Mortality rate was nil during the entire study period in the RAS units.



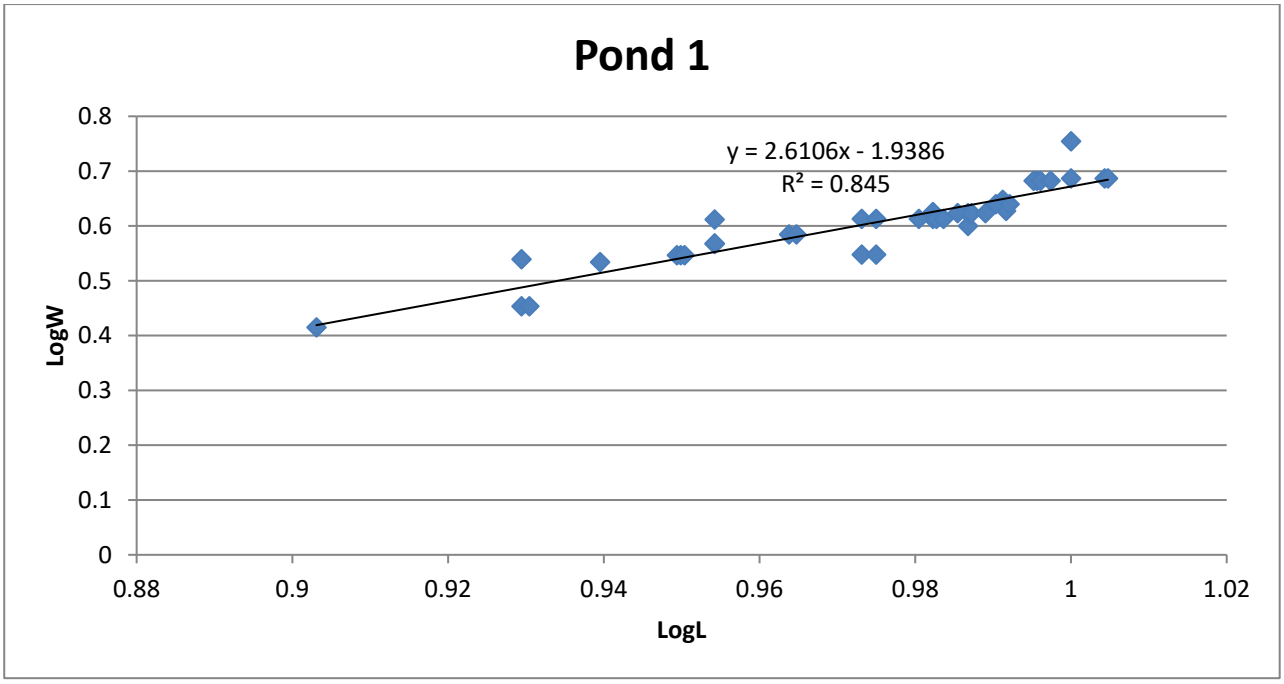
a. Length weight analysis of *Ompok pabda* reared using RAS unit 1



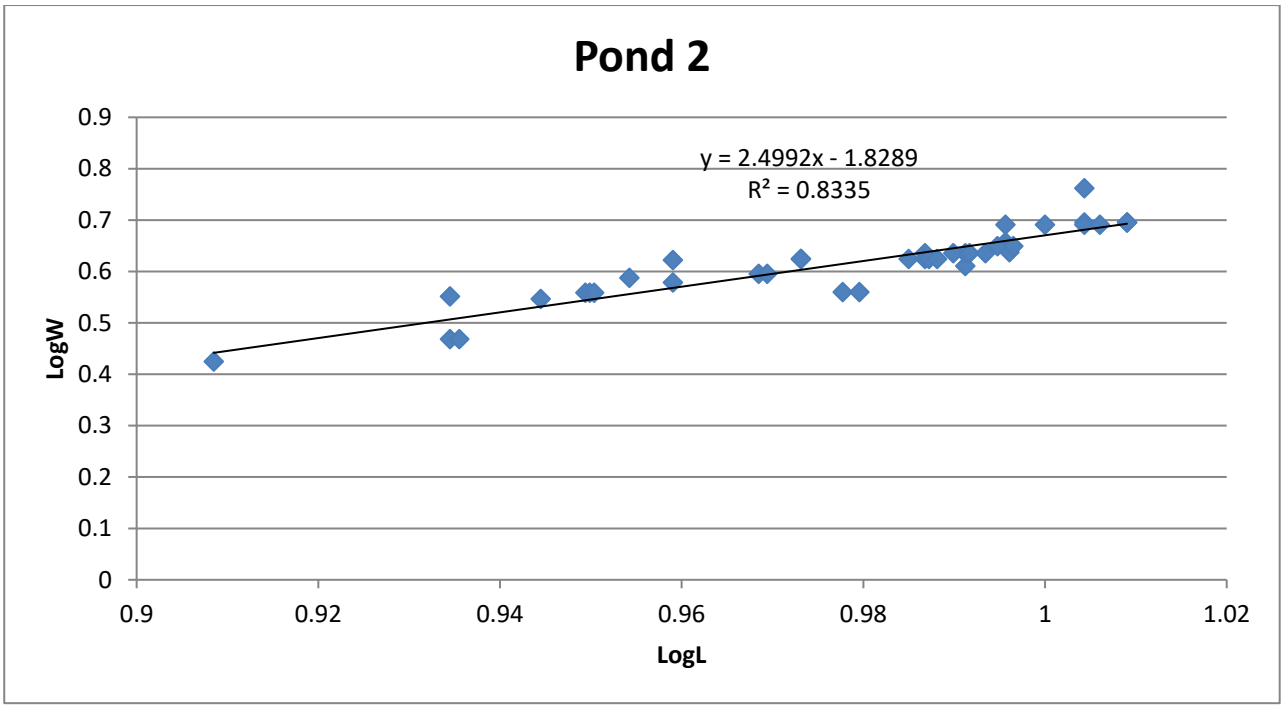
b. Length weight analysis of *Ompok pabda* reared using RAS unit 2



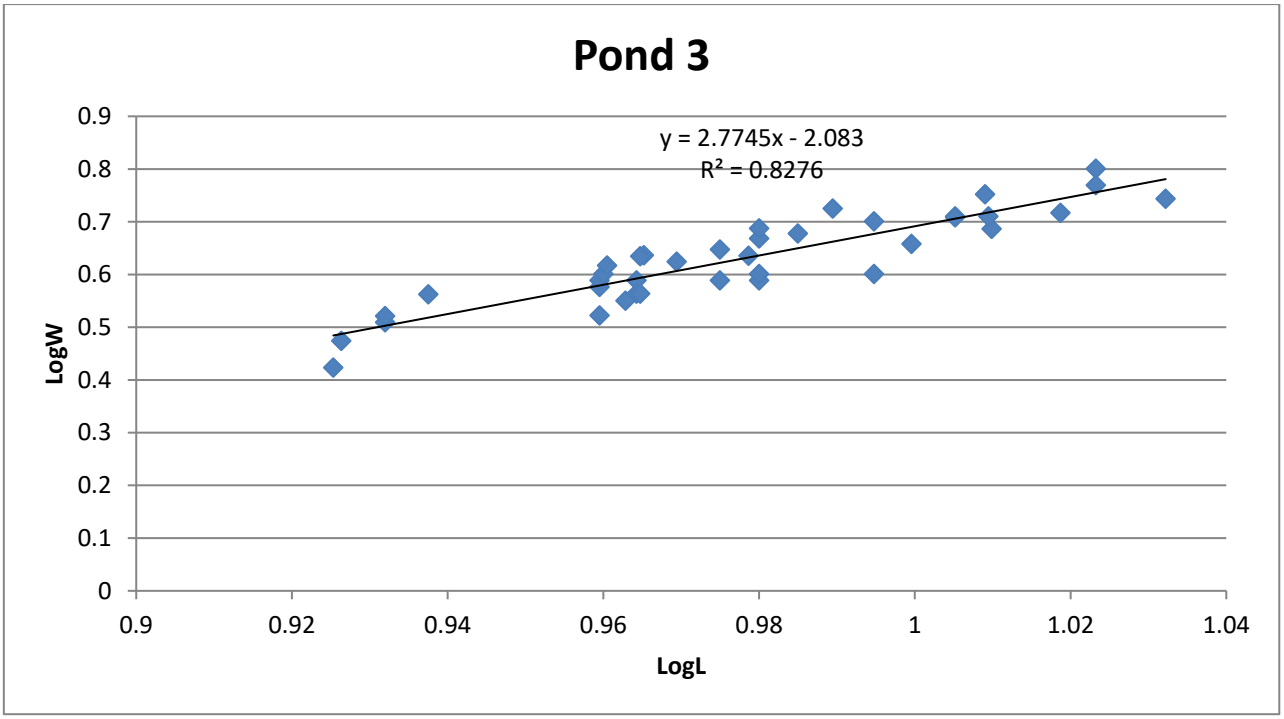
c. Length weight analysis of *Ompok pabda* reared using RAS unit 3



d. Length weight analysis of *Ompok pabda* reared in Pond 1



e. Length weight analysis of *Ompok pabda* reared in Pond 2



f. Length weight analysis of *Ompok pabda* reared in Pond 3

Figure 1. Comparison of Length weight analysis of *Ompok pabda*, one reared using RAS (a, b, c) and the other reared in pond (d, e, f)

Table 3. Minimum and maximum length range, regression parameters, 95% confidence interval, regression coefficient and Condition factor for *Ompok pabda*

	N	Total length (cm)		Body weight (gm)		Regression parameters		95% CL of a	95% CL of b	r^2	K
		Min	Max	Min	Max	a	b				
RAS tank 1	150	8.20	12.15	2.5	9.6	0.0012	2.91	0.0009-0.0015	2.76-3.06	0.9069	1.0032
RAS tank 2	150	8.32	10.67	2.55	5.78	0.0081	2.78	0.0077-0.0085	2.53-3.03	0.8224	1.0031
RAS tank 3	150	8.42	10.77	2.64	5.86	0.0068	2.84	0.0066-0.0070	2.59-3.09	0.8836	1.0032
Pond culture 1	150	8.05	10.11	2.6	5.68	0.0115	2.61	0.0113-0.0117	2.45-2.77	0.845	1.0016
Pond culture 2	150	8.62	10.21	2.65	5.79	0.0148	2.49	0.0144-0.0152	2.28-2.70	0.8335	1.0023
Pond culture 3	150	8.10	10.10	2.5	5.57	0.008	2.77	0.006-0.010	2.56-2.98	0.8276	1.0015

4. Discussion

The condition required for management of the fish *Ompok pabda* was in accordance with that of other authors. As reported by Chakrabarti *et al.* [17], the favourable pH for broodstock management was between 7.4–7.8. In the current study too the fishes were maintained in water having pH ranging from 7.4–7.5 in RAS units. The value of regression parameter 'b' found in the study ranged from 2.78–2.91 in the three RAS units indicating growth approaching isometry. Fluctuations in b values in the tanks revealed that the length-weight relationships of this species followed the cube law and might be affected by the improved growth condition provided by the biological filtration system and mechanical filtration system. The obtained value of 'b' conforms to the 'b' value found by other authors. Gupta *et al.* [18] has found the value of regression parameter 'b' of *Ompok pabda* to be ranged from 2.81 to 3.32 ($r^2 > 0.90$) in the River Gomti. Sani *et al.* [19] has found the value of 'b' of *Ompok pabda* to be 2.87 showing allometric growth in the River Betwa and River Gomti. Pampa Bhattacharjee and Prasenjit Pal [20] had found the value of 'b' to 2.5657 showing allometric growth in *Ompok pabda* from Tripura. Haji Muhammad *et al.* [21] reported the value of 'b' of *Ompok pabda* to be 2.22 showing allometric growth from Indus River Pakistan. The current value of 'b' (2.91) in the first RAS tank was higher than those reported by other authors perhaps due to the better growth medium provided. Due to the high rate of nonstop oxygen supply, the D.O. was sufficiently higher and as a result no mortality rate was observed. Good condition factor was reported during the study (K_n=1.0032) which was similar to that reported by Bhattacharjee and Pal [20].

5. Conclusions

The current study has provided the evidence of improved growth condition and hence improved growth using RAS technology in comparison to pond culture where the growth is slow. Therefore if such a system can be provided for rearing this fish species without any observed mortality then this Near Threatened fish species can be easily captivated.

6. Summary

Ompok pabda [3] also known as pabda or butter catfish is a highly esteemed small indigenous freshwater fish commonly found in natural water bodies of Northeast India. This fish is a good candidate species for aquaculture but during the course of time the species has undergone significant decline due to over exploitation and hence placed in Near Threatened category by IUCN [2]. This fish species was reared in RAS and its length weight relationships were derived for assessing its growth conditions. The value of 'b' recorded in the fish species using RAS technology ranged from 2.78 (r^2=0.822) to 2.91 (r^2=0.90) respectively which was higher than that of the fish species reared in pond ranging from b=2.49 (r^2=0.8335) to b=2.61 (r^2=0.84). Zero mortality was observed during the entire study.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

Data Availability Statement

All data generated in the present study are included in the manuscript and its figures, tables and supplementary files.

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