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Captive breeding and seed production techniques of Endangered Giant River Catfish *Sperata seenghala*

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Abstract
A study was conducted to observe the breeding and seed production techniques of endangered giant river catfish, *Sperata seenghala*, locally known as "guizza air''. In this study, a total of 60 pairs of adult guizza air (850-1500 g) were collected from the Brahmaputra river-basin and floodplains in Mymensingh region and stocked in a 40 decimal pond with 2.5-3 feet depth three months before the onset of the breeding season. Hatchlings gradually started to consume zooplanktons available in the spawning pond and no artificial feeds were used. Fry numbering 50,280 with a mean ± SD length and weight of 1.91 ± 0.24 cm and 0.25 ± 0.07 g, respectively were collected by repeated netting with mosquito net from the spawning pond after 15 days of spawning. The fry were then stocked at 1000 fry/dec in two earthen nursery ponds having area of 20 and 30 decimal with an average depth of 3 feet. Fry in two nursery ponds were reared with commercial nursery feed for the first 14 days and pre-starter feed during days 15-28. The water temperature in the nursery ponds was ranged from 30.53 ± 0.71 to 32.85 ± 0.49 ºC during nursing. The values of dissolve oxygen (DO) and pH ranged from 6.50 ± 0.41 to 4.27 ± 0.71 ppm and 7.8 ± 0.62 to 7.2 ± 0.47, respectively. The final average length and weight of the fingerlings were 6.26 ± 0.21 cm and 2.55 ± 0.08 g, respectively after four weeks of nursing. The survival rate of fry was 63% with a net production was 630 fry/dec. It can be concluded that the captive breeding and seed production techniques of *S. seenghala* described here is an important step in conservation and pond culture of the endangered *S. seenghala*.

Keywords: Captive breeding, seed production techniques, endangered *Sperata seenghala* etc

1. Introduction
Captive breeding of indigenous and exotic aquaculture species for seed production has been a common practice in Bangladesh since 1967 [3]. Most hatcheries rear their own brood stock and usually do not recruit brood stock from natural sources (rivers) or exchange breeders between farms. Each hatchery therefore, can be considered as an isolated, self-sustaining and genetically closed unit [9]. It is established that in genetically closed hatchery systems, potential selective pressures exerted on finite and often small culture populations by various farm management practices such as the selection of founder stock, number of breeders maintained, method of replenishing brood stock, stocking density, feeding regime etc. can result in indirect or negative selection, inbreeding and genetic drift [9].

One of the important bagrid catfish is the giant river catfish *Sperata seenghala*, locally known as "guizza air" and was once available in rivers, floodplains, inundated swamp fields, ditches, canals and other freshwater areas throughout Afghanistan, Pakistan, India, Nepal and Bangladesh [11]. This species is also found in the Chalan Beel, Choto Jamuna River, Halti Beel [10]. It has been considered as one of the most admired edible fish among indigenous catfish species due to good taste and high market demand. It is commercially fished for human consumption as well as being a popular game fish with a reputation for being a good fighter when hooked. It can be distinguished from other *sperata* species by its spatulate, blunt snout, relatively short barbels and mouth that is only 1/3 as wide as the head is long [12]. The fish is carnivorous and predatory in nature, subsists on various types of organisms such as fish, frogs, snakes, insects, earthworms, tadpoles, crustaceans and debris [15]. Food at different life stages: insects and fish-fry (fry); water fleas, fish-fry, insects and smaller fingerlings (fingerling); Insects, tadpoles and fish (Adult) [18]. Gut content analysis of *S. seenghala* indicate that the gut content consists of about 80-90% is animal food matter of which the major food components

are locally available weed fish species *Puntius ticto, Chela phulo, Ambassis nama*. The percentage of animal matter in the diet is increased by 5-10% with increase in body size from Small (20-25cm) to large (60-65cm) [4].

This fish usually spawns twice a year from May to July and from September to November in natural condition [15]. Early and developing stage oocytes were mostly observed during April-May, maturing oocytes in June, and mature oocytes during July-August. Early and developing germ cells were mostly observed during April-May, gradually maturing in June, and mature germ cells during July-August sections of testes. The combination of ovarian and testicular histology summarizes that *S. seenghala* breeds during late monsoon. It is remarkable that, while many fish species from the freshwaters start to breed with the first rain in the year, *S. seenghala* breeds in the late monsoon [1].

This fishes are testy and have high market value. As a result, development of artificial propagation and mass seed production techniques might create excellent livelihood opportunities for hatchery and nursery operators, fish farmers and traders. Steps should be taken to develop induced and controlled natural breeding technique for small and medium scale seed production of *S. Seenghala.* Captive breeding and mass seed production techniques of *S. seenghala* should be developed to supply the seeds for commercial farming as well as to save the gene pools of these valuable species. Present study was conducted to achieve following objectives:

- To gain practical experience of captive breeding and seed production techniques of the giant river catfish *S. seenghala*.
- To increase seed production of *S. seenghala* through scientifically improved nursing technique.
- To conserve the species *S. seenghala* through mass seed production.

2. Materials and Methods

2.1 Study area and time

The present research work was a study on captive breeding and seed production techniques of endangered giant river catfish started on March 2014 and it was conducted in the ponds located in the Desh Bondhu Hatchery of Mymensingh, Bangladesh and Nursery from April 2014 to August 2014.

2.2 Spawning pond preparation

An earthen pond was selected for captive breeding of guizza breeders. The area of the selected pond was 40 dec with 2.5-3 feet depth. The experimental pond was prepared by using rotenone at the dose of 20 mg/L water for eradicating unwanted fish species. Fertilizers were applied to increase the plankton density in pond water. Seven day after fertilization, the pond water became greenish with the abundance of phytoplankton and zooplankton and ready for brood stocking. For stimulating the natural propagation of guizza air, the spawning pond was supplied with fresh groundwater to maintain a natural condition (e.g., temperature adjustment, water circulation, mate selection, sex stimulation, and courtship induction) for breeding.

2.3 Collection of broods and stocking in the spawning pond

Broods were collected from the brood rearing pond of the farm. A total of 60 pairs of adult guizza air (60 males and 60 females) weighing between 850 and 1500 g were collected three months before the onset of the breeding season. Brood fish were collected from the brood rearing pond by repeated drag netting, segregated and transferred into spawning pond.

2.4 Rearing of broodstock and its management

Fish were fed twice daily with supplemental feed at the rate of 5–6% of the estimated fish biomass. The pond was fertilized at biweekly intervals with cow dung (5 kg/dec) and urea and triple super phosphate (200 g/dec) to accelerate the primary productivity of the ponds throughout the entire rearing.

2.5 Nursery pond selection and preparation

Two ponds were selected for nursing of guizza air fry. The areas of the selected two ponds were 20 and 30 dec, respectively with average depth of 2.5-3 feet. Deep ground water was collected and used for nursing guizza air fry.

2.6 Collection of fry from spawning pond

After 15 days of spawning, a total of 50,280 guizza air fry were collected from the spawning pond by mosquito net. After collection, the fry were transferred to prepared earthen nursery ponds for four weeks of nursing. Fry having a (mean ± SD) length of 1.91 ± 0.24 cm and weight of 0.25 ± 0.07 g, taken from 20 randomly sampled individuals, were then stocked in two nursery ponds.

2.7 Stocking and rearing of fry in nursery pond

A total of 50,000 fry were stocked at a rate of 1000 fry/dec in two nursery ponds. In nursery ponds, watering is done up to 3 ft depth and 100 g flour/dec is mixed with pond water. This flour results in growth of plenty of zooplankton which is very essential for fry. After two days of fry stocking, 3 ml/dec sumithion is added to the nursery pond water in order to kill haspoka.

2.8 Feeding of fry

In nursery pond, blended eggs were supplied as first feed. Ten blended eggs are enough for 20 dec nursery ponds. Nursery feed was applied 3 times/day (morning, noon, evening). After four weeks of nursing, fry attained the size of 6.26 ± 0.21 cm and 2.55 ± 0.08 g in length and weight, respectively which were ready for marketing.

2.9 Water quality monitoring

Various water quality parameters such as temperature (°C), transparency (cm), dissolved oxygen (mg/L), pH, ammonia nitrogen (mg/L) were recorded weekly between 9 am and 10 am throughout the experimental period. Water samples were collected from spawning and nursing pond. All the water quality parameters were measured on the spot.

2.10 Methods for physical and chemical factors estimation

The transparency of water was measured by a standard secchi disc fitted to a rope. Water temperature of the experimental ponds was recorded in Celsius (°C) by holding a Celsius thermometer under water for 1 minute. pH and DO were determined by using portable pH and oxygen meter, respectively.

2.11 Fry sampling

Fifty individuals from each pond were sampled weekly until they attained the fingerling stage. Fish sampling was done to adjust the feeding rate by measuring the weight of fish, to observe the health condition and to keep the record of length and weight of fish. After recording the length and weight of the fry they again were released to the respective ponds.

2.12 Growth study

For comparative growth study of fry for the research work, the following growth parameters were calculated and analyzed. Survival rate, specific growth rate (%SGR), length gain (LG) weight gain (WG), feed conversion ratio (FCR) were calculated by using the following formula:

$$\text{Survival rate} = \frac{\text{No. of total fry obtained}}{\text{No. of total fry stocked}} \times 100$$

$$\text{SGR (\%/ day)} = \frac{\text{Log eW}_2 - \text{Log eW}_1}{T_2 - T_1} \times 100$$

Where, W_1 = Initial body weight (g) at time T_1 (day) and W_2=Final body weight (g) at time T_2 (day)

Average length gain (cm) = Average final length (cm) - Average initial length (cm)

Average weight gain (g) = Average final weight (g) - Average initial weight (g)

Average weight gain (g)/day at different week

$$= \frac{\text{Weight (g) in present week - Weight (g) in previous week}}{\text{Days of week}}$$

$$\text{FCR} = \frac{\text{Total feed used}}{\text{Final body weight (g)} - \text{Initial body weight (g)}}$$

2.13 Harvesting

Fingerlings were collected from the nursery pond after four weeks. While collecting for sale, each fingerling length was about 6.26±0.21 cm and weight was 2.55±0.08 gm. complete harvesting was done by seine net.

2.14 Cost and profitability analysis

Analysis of different cost throughout the nursing period was done depending on data collected from the farm manager in order to determine the profitability and potentiality of guizza air culture. These costs include several fixed and variable cost such as cost of pond preparation, price of seed and feed, labor cost, price of fertilizer, lime and water supply cost. Benefit-cost ratiocan be calculated by using the following formula:

For 1 year tenure there is no discount factor, hence benefit cost ratio should be,

Benefit-cost ratio =

$$\frac{\text{Present value of benefit}}{\text{Present value of cost}}$$

3. Results

The growth performance and production of giant river catfish *Sperata seenghala* and the water quality parameters obtained in the present study are presented below:

3.1 *Sperata seenghala* spawning

In the present study, spawning pairs of *S. seenghala* were found to excavate holes (nests) at the edge of the pond dike at about 2 to 2.5 feet below the water surface during breeding season. In the nests, one male was found with a female moving together randomly for certain time, closed to each other, nudge each other and become aggressive within a limited area. This process was repeated several times until spawning. The size of holes was differ from 1.5 to 2 feet in diameter with 6 to 7 inch in depth where female laid eggs at night during 4th week of June, 2014. Average water temperature during spawning was 30.37 ± 0.58 ºC. Fertilized eggs hatched within 2-3 days. Following spawning, females protected their nests and showed extreme parental care up to 10 to 15 days. Near the end of and immediately after the yolk sack absorption females fed their young with their own skin mucus. In the nest, females were found to lose their skin mucus and the color of the body changed from brownish back and whitish to reddish. Hatchlings gradually started to consume zooplanktons available in the spawning pond and no artificial feeds were used. The total number of fry collected from the spawning of 60 pairs of *S. seenghala* was 50,280 (838 fry/pair) with a mean ± SD length and weight of 1.91 ± 0.24 cm and 0.25 ± 0.07 g, respectively. After 15 days of spawning, fry numbering 50,000 were transferred to prepared earthen nursing pond for four weeks of nursing.

3.2 Feed application rate

To maintain proper growth rate of guizza air fry, it is necessary to apply appropriate type and amount of feed. To obtain desired seed production of guizza air fry feed should contain 35% protein. In market, now a days, there are various types of feed available which contain higher amount of protein. In this study, mainly two types of feed were used in different stages of nursing. Nursery feed (powder) was used for first two weeks and floating Pre-starter feed was used for next two weeks of nursing period. Based on the nursing period, the types of feed and feed application rate are given in the following Table 1:

Table 1: Types of feed and feed application rate in nursing of guizza air fry

Culture stage	Nursing			
Week	1st	2nd	3rd	4th
Types of feed	Nursery feed		Pre-starter feed	
Artificial feed (kg)	14	33	50	75
Feeding rate (% of body wt)	14		12	
FCR for artificial feed	0.70	1.32	1.67	1.88

3.3 Growth and production of fry

During the nursing period, different growth parameters such as the average length (cm), average weight (g), average daily weight gain (g/day), specific growth rate (SGR%), survival rate (%), net production (number/dec) was observed. The net production (number/dec) of guizza air fry was 630 fry/dec. The survival rate of guizza air fry was 63%. Different growth parameters of guizza air fry are given below in Table 2.

Table 2: Different growth parameters of fry during nursing period

Culture stage	**Nursing**				
Week	Initial (mean±SD)	1st (mean±SD)	2nd (mean±SD)	3rd (mean±SD)	4th (mean±SD)
Average length(cm)	1.91±0.24	2.98±0.28	4.55±0.34	5.68±0.27	6.26±0.21
Average weight (g)	0.25±0.07	0.65±0.09	1.15±0.06	1.75±0.07	2.55±0.08
Average daily weight gain (g)/day	0.02±0.07	0.06±0.09	0.07±0.06	0.09±0.07	0.11±0.08
SGR (%)	0	13.65±0.09	8.15±0.06	5.99±0.07	5.38±0.08

3.4 Water quality parameters

The physico-chemical parameters like water temperature (ºC), dissolved oxygen (mg/L), pH, water transparency (cm), and ammonia nitrogen (mg/L) were recorded weekly during the experimental period is presented below in Table 3.

Table 3: Weekly water quality parameters observed during nursing period

Week	1st (mean±SD)	2nd (mean±SD)	3rd (mean±SD)	4th (mean±SD)
Temperature (ºC)	32.85±0.49	32.38±0.67	31.78±0.42	30.53±0.71
Dissolved Oxygen (mg/L)	6.0±0.82	6.50±0.41	5.37±0.63	4.27±0.71
Transparency (cm)	37.84±2.02	32.67±2.08	29.17±1.89	24.34±1.26
pH	7.6±0.12	7.8±0.62	7.5±0.71	7.2±0.47
Ammonia nitrogen (mg/L)	0.0	0.19±0.02	0.41±0.04	0.68±0.02

3.5 Cost and profitability analysis

There were different site of cost in the nursing period of guizza air. The total production cost of fry was 1, 04, 870. 00 BDT, total income was 3,78,000.00 BDT and benefit was 2,73,130.00 BDT. Benefit-cost ratio was 3.60. Total cost of production and profitability are given in the Table 4.

Table 4: Cost and profitability analysis of guizza air fry nursing

Expanses in production area	Amount	Cost (BDT)/unit	Total cost (BDT)
a. Management expanses			
1. Pond lease cost	(30+20) or 50 decimal	500.00/decimal	25,000.00
2. Labor cost (provides protection, feed supply, weed cleaning etc.)	1 person	5,000.00/month	5,000.00
3. Net dragging or doing horra	1 times	200.00/time	200.00
4. Water supply			2,000.00
5. Electricity			1,000.00
6. Others			2,000.00
Partial total			35,200.00
b. Cost of pond preparation			
1. Pond repairement	10 labor	250.00/labor	2,500.00
2. Pond drying and removal of other fishes			1,500.00
3. Lime application	50 kg	20/kg	1,000.00
4. Cow dung	500 kg	0.5/kg	250.00
5. Fertilizer	20 kg	30/kg	600.00
6. Medicine			1,500.00
Partial total			7,350.00
c. Seed of guizza air	50,000 pieces	1.00/pc	50,000.00
d. Supplementary feed	172 kg	60.00/kg	10,320.00
e. Feed transportation and others			2,000.00
Total expanse (a+b+c+d+e)			1,04,870.00
Production & income			
i. Production of guizza air fry (63% survival rate)	31,500 pieces	12.00/piece	3,78,000.00
Total income			3,78,000.00
Actual income (total income-total expanse)			2,73,130.00
Benefit-cost ratio			3.60

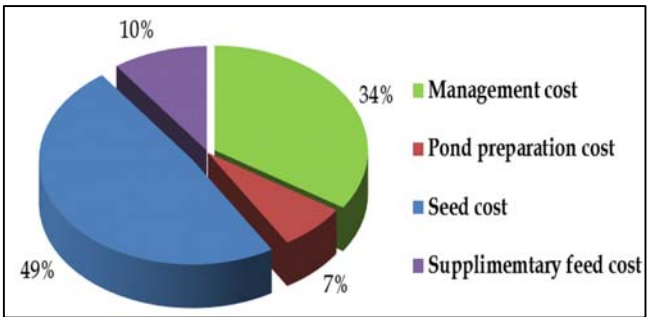

Fig 1: Cost of guizza air seed production in different sector

4. Discussion

The study showed the breeding, growth, specific growth rate (SGR %) and survival rate of *S. seenghala* fry fed on the same level of diets in the ponds having similar environmental conditions. However, many factors are related to the nursing such as stocking density, production system, type and size of rearing ponds, size of fish and quality and quantity of food [13].

4.1 *Sperata seenghala* spawning

In the present study, a total of 60 pairs of *S. seenghala* breeders successfully spawned in earthen pond which was also reported by Rahman *et al* [15]. In their study, they found 30 pairs of *S. seenghala* breeders naturally spawned in earthen pond. In this study, a total of 50,280 fry (838 fry/pair) were collected from the spawning pond. Rahman *et al.* [14] found 300 and 762 fry/pair from the spawning of 10 and 30 pairs of *S. seenghala,* respectively which is more or less similar to the findings of present study. In the present study, average water temperature of spawning pond was recorded 30.37 ± 0.58 ºC indicating quite favorable for breeding of *S. seenghala* is similar with the findings of Sarker *et al.* [16] for the breeding of *Chitala chitala* in which breeding temperature was 29 ± 2.2 ºC. In the present study parental care of female *S. seenghala* was observed during larval development by protecting nest and feeding their young with their own skin mucus. However, Chonder [6] reported that both male and female participate actively in parental care of *C. chitala*.

4.2 Growth performance

In the present study, the stocking density was 1000 fry/dec

during nursing of *S. seenghala*. Rahman *et al.* [14] observed that the growth, survival, production and net benefits of *S. seenghala* fry were inversely related to the stocking densities of fingerlings. Growth in terms of length, weight and survival of fry was lower in this study. The causes might include competition for food and habitat due to higher number of fish. The result of the present study is similar with the findings of Rahman *et al* [15]. In the present study, maximum average weight was 2.55 ± 0.08 g obtained from the fry fed with nursery and pre-starter feed containing 33% and 30% protein respectively. The observed result is in agreement with the report of Ali *et al.*(2) who tested the performance of different diets containing 25, 30, 35, 40% protein in dry weight basis and reported that 35% protein is optimum in diet for commercial rearing of *S. seenghala*. In this study, the average daily weight gain ranged from 0.02 ± 0.07 to 0.11 ± 0.08 g/day which is more or less similar to Rahman *et al*. [14] who found that guizza air fry can achieve a rate of growth from 0.01 to 0.07 g/day during nursing in earthen pond. The present result is in agreement with the report of Rahman *et al*. [15] who reported that the average daily weight gain of snakehead fingerlings ranging from 0.02 to 0.09 g/day. The SGR values of *S. seenghala* ranged from 5.38 ± 0.08 to 11.26 ± 0.09% in this study. It is evident from the results of SGR values that, with the increase of age the values of SGR decrease. This finding resembles the Medawars [12] fifth law "the specific growth declines more and more slowly as the organism increases in age". The SGR% value of *S. seenghala* fry in this study also shows the same trend. In this study, the FCR value ranged from 0.70 to 1.88 which is lower than Ali *et al.* [2] who found that the FCR value of *S. seenghala* and *Channa striatus* to range from 2.02 to 2.15 and 2.71 to 2.87, respectively. De Silva and Davy [7] reported that digestibility plays an important role in lowering the FCR value by efficient utilization of food. However, the lower FCR value in the present study indicates better food utilization efficiency. Present study shows survival rate of *S. seenghala* fry was 63% which is lower than Rahman *et al.* [14] who found survival rate of *S. seenghala* fry was 69.25% in their 56 days experiment with artificial feed. Lower survival rate of *S. seenghala* fry is achieved because of higher stocking density in the present study. Productions (gross and net) of guizza air fryfound in this study were 31,500 pieces and 630 pieces/dec. Rahman *et al*. [15] found a gross production of 112,500 to 117,000 fingerlings ha^{-1} following the culture of snakehead *(Channa striatus)* for two months at 150,000 fry ha^{-1} stocking densities. Rahman *et al*. [14] observed that under the monoculture condition, the production of guizza air fry was 65,321 to 72,179 pieces ha^{-1} for two months at 100,000 fry ha^{-1} stocking densities.

4.3 Water quality parameters

In the present study, the water temperature ranged from 30.53 ± 0.71 to 32.85 ± 0.49 ºC in the nursing pond. The result is more or less similar to Rahman *et al*. [15] who recorded temperature to range from 26.0 to 35.0 ºC, 22.0 to 34.0 ºC, 24.2 to 32.0 ºC and 28.60 to 31.90 ºC, respectively. These results agree well with the findings obtained by Rahman *et al*. [15]. Dissolved oxygen (DO) in the present study was found to vary from 4.27 ± 0.71 to 6.50 ± 0.41 mg/L in the nursery pond. DoF [8] suggested the suitable range of DO as 5.0 to 8.0 mg/L. The concentration of dissolved oxygen in the present study was also similar to the findings of Wahab *et al.* [17] who recorded dissolved oxygen to range from 2.7 to 7.2, 4.0 to 7.0 and 4.3 to 6.9 mg/L, respectively. Water transparency is generally expressed as the level of productivity of water body and also indicates the presence or absence of plankton in a water body. In the present study, transparency ranged from 24.34 ± 1.26 to 37.84 ± 2.02 cm which assumed to be the suitable level. Wahab *et al.* (17) suggested that the transparency of productive water should be 40 cm or less. pH is considered as an important factor in aquaculture and treated as the productivity index of a water body. In the present study, pH was found to fluctuate from 7.2 ± 0.47 to 7.8 ± 0.62 and considered as suitable range for fish culture. The pH value recorded from the experiment agreed with the findings of Ali *et al.* [2] who found pH to range from 7.55 to 7.84, 7.05 to 7.72, 7.51 to 7.91, 7.40 to 8.80, and 7.50 to 8.40, respectively. The presence of ammonia in pond waters is normal due to natural fish metabolism and microbiological decay of organic matter. The total Ammonia (NH_3) concentration was found to vary from 0.0 to 0.68± 0.02 mg/L during the study period which is similar with the findings of Rahman *et al*. [15] who recorded ammonia-nitrogen value to range from 0.01 to 0.82 and 0.203 to 0.569 mg/L, respectively and also more or less similar with Rahman *et al* [14] who recorded ammonia- nitrogen value to range from 0.268 to 0.327 and 0.94 and 1.58 mg/L, respectively.

4.4 Cost and profitability analysis

In the present study, an economic analysis was performed to estimate the net profit from seed production of *S. seenghala*. The findings came up from the study that the production of *S. seenghala* was 630 fry/dec and per dec total return was 7,560.00 BDT for the nursing period. Cost of production was 2,097.40 BDT per dec and the Benefit Cost Ratio (BCR) was 3.60. So, seed production of *S. seenghala* is profitable. Cost of fry, labor cost, feed cost, fertilizers and chemicals cost and nursing period included in the profit frontier had a significant influence on profit of *S. seenghala* fry nursing in this study. Rahman *et al*. [14] found BCR for *S. seenghala* fry nursing was 4.23 in their study which is more or less similar to the present study. Rahman *et al*. [15] observed the BCR of tilapia culture was 1.25 in his study of profit efficiency of tilapia monoculture in Trishal upazila of Mymensingh district.

5. Conclusion

The result of present study clearly indicates that captive breeding of *S. seenghala* in natural condition is possible and fingerlings produced from the nursing can be used for rearing to marketable size. Evidently, captive breeding program should be undertaken for species restoration and conservation. As the fishes are testy and have high market value, development of captive breeding and mass seed production techniques might create excellent livelihood opportunities for hatchery and nursery operators, fish farmers and traders. The meteorological and hydrological conditions are suitable for the breeding of this fish species. Biologically productive natural water with controlled weed growth and rich phytoplankton, zooplankton and macro invertebrate fauna would be ideally suited for the growth of guizza air fish. The results of the current experiment suggest that *S. seenghala* is a suitable and potential species for captive breeding in small scale fish hatchery and commercial culture.

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