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RESEARCH ARTICLE

Proximate Analysis of three Brackishwater Fish Species Cultured in Artificial Tank: A Search for Climate Resilient Alternative Livelihood

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ABSTRACT

Biochemical composition of three brackishwater fish species (*Macrobrachium rosenbergii, Scatophagus argus* and *Etroplus suratensis*) from Indian Sundarbans were compared during December, 2013. Culture of these species was initiated in artificial tank at Techno India University Campus at Salt Lake, Kolkata during October, 2013 and the analyses were done after three months. *M. rosenbergii* contains significantly higher crude protein (52.34%) than *S. argus* (52.65%) and *E. suratensis* (47.24%). The highest percent of crude lipid (8.34%) and carbohydrate (29.54%) contents are also recorded in *M. rosenbergii*. These biochemical attributes make these species ideal brackishwater aquacultural products that can be linked with the alternative livelihood of Sundarbans people. Such study has great relevance from the societal point of view as saline water intrusion into fresh water ponds often occurs in the Sundarbans due to tidal surges and several natural disasters to which the Sundarban islands are prone to. Also the culture of the three species in the same system can maximize the profit and efficiency of utilization of culture space.

KEYWORDS

Biochemical Composition, *Macrobrachium rosenbergii, Scatophagus argus, Etroplus suratensis*, ANOVA

INTRODUCTION

Climate change, which is an inevitable truth of the present world, has posed constraints on livelihoods by affecting the assets and natural resources directly and indirectly. Direct impact of climate change on livelihood assets includes: temperature rise affecting crop production, human health (directly by heat waves), sea level rise causing salinization of coastal land, ground water aquifers etc, sea level rise posing adverse impact on agriculture, freshwater fishery etc., increased tidal surges causing crop loss, mangrove and coastal vegetation loss etc. and reduced availability of economically important fishes from coastal waters.

Indirect impact of climate change on livelihood assets includes: alteration of salinity influencing plankton community (the food for fish) thereby affecting fish population, pH level depression causing coral and oyster reef deterioration –

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thus threatening the shelter ground of fishes, sea level rise causing shrinkage of mangrove areas and landward migration of mangroves thereby threatening the nursery of finfish and shellfish juveniles, and temperature rise enhancing microbial diseases in aquaculture sector by accelerating plankton bloom.

According to the World Resources Institute, 2.2 billion people, or 39% of the world's population, live on or within 100 kilometers (60 miles) of seashore. We have not ever imagined the dark fate of this considerable chunk of population due to sea level rise or natural disasters (like tsunami, cyclone etc.). These obvious problems cannot be escaped – either the problems will ruin away the population or the population will have to overcome the problems by mitigation and adaptation. The livelihood sector is greatly influenced by the events of climate change. If the population is adapted to new livelihood the cost of mitigation is reduced. It has been documented that the cost of adaptation is inversely proportional to the costs of mitigation and to that of the cost of unmitigated climate disruption impacts. The livelihood is thus a vital sector in the sphere of climate change associated economics.

The present paper is an attempt to evaluate the nutritional status of three brackishwater fish species (M. rosenbergii, S. argus and E. suratensis) that can be cultured in the same system and may provide a road map for alternative livelihood to Sundarbans island dwellers. Biochemical composition of fish tissue is of significance because tissue's constitutes a rich source of nutrients and caloric value1. The approach is unique as:

(i) The brackishwater ponds in Sundarbans can be utilized at optimum level.

(ii) The species combination can upgrade the economy of the beneficiaries.

(iii) The species combination can upgrade the ecological health of the culture system.

(iv) The freshwater system can generate productivity even after saline water intrusion due to tidal surges and disasters which are very common in the region.

MATERIALS AND METHOD

Study Area

The present study was conducted in an artificial brackishwater tank constructed at Techno India University campus in Salt Lake city, Kolkata (22°34′02.2″N and 88°25′41.5″ E). Fish samples were collected from Kakdwip (latitude 21°53′00″N to 21°88′33″ N and longitude 88°11′00″ E to 88°18'33″ E.) and introduced into fibre glass tank (180 cms × 89 cms × 74 cms) filled with artificial seawater prepared as per the standard method.[2] 10 individuals of each species were introduced after acclimatization and their biochemical composition was analyzed after three months of survival period.

Biochemical Analysis

Duplicate analyses were averaged for each of the triplicate samples for carbohydrate, total protein and total lipid. The total protein content was determined with Folin reagent with bovine albumin serving as standard.[3] The total carbohydrate content was assayed by the phenol-sulphuric acid method[4] after extraction with 2.5N HCl. The results were calculated from a glucose standard curve. Total lipid was determined by Soxhlet method.[5] Protein, carbohydrate and lipid contents were expressed as the percentage dry weight (DW).

Hydrological Characteristics

Water samples from the artificial brackish water system was collected for analysis of hydrological parameters like surface water temperature, salinity, pH, dissolved oxygen (DO), nitrate (NO_3), phosphate (PO_4) and silicate (SiO_3) after three months of the release of fish fingerlings. Analyses were done as per the standard protocols.[2,6]

Statistical Analysis

The results of all analysis were expressed in the format mean ± Standard Deviation. The mean values of biochemical parameters were subject to ANOVA ($p<0.05$) to evaluate whether

significant variation in biochemical composition exist between the three selected species.

RESULTS

(i) The protein percentage (dry weight basis) ranges from 47.24 ± 01.85 (in *E. suratensis*) to 52.65 ± 02.02 (in *S. argus*).

(ii) The lipid percentage (dry weight basis) ranges from 6.08 ± 0.98 (in *E. suratensis*) to 8.34 ± 0.72 (in *M. rosenbergii*).

(iii) The carbohydrate percentage (dry weight basis) ranges from 23.73 ± 01.01 (in *E. suratensis*) to 29.54 ± 01.09 (in *M. rosenbergii*).

(iv) The order of biochemical parameters exhibited unique species specificity. In case of protein, the order is S. argus > M. rosenbergii > E. suratensis. The order for lipid and carbohydrate is M. rosenbergii > S. argus > E. suratensis. This inter-specific variation is statistically significant ($p<0.05$) as observed through ANOVA (Table 2)

(v) The surface water temperature varied from 27.0ºC (during December, 2013) to 30.3ºC (during October, 2013). The range of salinity and pH varied from 3 psu (during October, 2013) to 5.03 psu (during December, 2013) and 7.29 (during December, 2013) to 7.80 (during October, 2013) respectively. The dissolved oxygen decreased with time (Table 3).

(vi) It is observed that NO_3 and PO_4 values increased with time, which is opposite to the trend of SiO_3 (Table 3).

Table1: Proximate composition of three brackishwater fish species

Species	Protein (%)	Lipid (%)	Carbohydrate (%)
E. suratensis 	47.24 ± 01.85	6.08 ± 0.98	23.73 ± 01.01
S. argus 	52.65 ± 02.02	7.39 ± 0.67	26.11 ± 0.98
M. rosenbergii 	52.34 ±01.96	8.34 ± 0.72	29.54 ± 01.09

Table 2: ANOVA of Biochemical composition

	F_{cal}	F_{crit}	Remarks
Between Species	7.79	6.94	Significant

Table 3: Monthly variations of Hydrological characteristics

Month	Temperature (ºC)	Salinity (psu)	pH	DO (mg/l)	NO_3 (µgmat/l)	PO_4 (µgmat/l)	SiO_3 (µgmat/l)
October, 2013	30.3	3.50	7.80	5.16	15.83	2.14	31.66
November, 2013	29.8	4.10	7.65	4.98	16.01	2.49	30.77
December, 2013	27.0	5.03	7.29	4.03	16.97	2.93	27.10

DISCUSSION

The hydrological parameters (except pH and salinity) showed an increase with the time which may be attributed to their growth and increase of biomass (Table 3). The decrease of pH with time is the reflection of increase biomass of excreta with age and body size. As the excreta are acidic in nature therefore, the pH value normally decline with time.

The results showed broad variations in proximate composition between species. This variation is significant at 5% level as evidenced through ANOVA (Table 2). In this experiment parameters such as year, season, maturity and age, that influence energy values and biochemical composition[7,8] could not be studied properly as it is a one-time observation. A long term data bank needs to be developed to document inter-specific variations in proximate composition and energy content especially for fat, which could have notable seasonal variations.[9]

The feed type may have a regulatory role on the biochemical composition of the fish species. *E. suratensis* is a bottom feeding scavenger with a tendency for herbivory. Filamentous algae *Spirogyra* formed an important item of the diet. Researchers showed that *E. suratensis* feeds mostly on decayed organic matter (38.6%), filamentous algae (29.15%) and miscellaneous food items (8.04%).[10] Sand grains (3.89%) present in the stomachs during some months indicate a tendency for feeding at the bottom. Earlier reports had indicated that the young ones of this species are herbivores.[11,12] Researchers have observed that though it feeds on micro and macro vegetation, its food mainly consists of invertebrates such as insect larvae, bivalves, mysids and decayed organic matter.[13,14] Many workers have documented that in the estuarine habitat of the Mangalore region the major food items of this species are filamentous algae.[15] In these fishes they recorded detritus (24.39%) and sand particles (9.83%) also in appreciable quantities.

Prawns subsist almost on every kind of food available in the environment including diatoms, blue green and green algae, insects, crustaceans, organic detritus, sand and mud.[16] *M. rosenbergii* of Indo-pacific region has been observed feeding on aquatic worms, molluscs, crustaceans, fish flesh, grains, seeds, nuts, fruits, algae and other aquatic vegetation.[17] Researchers has also found *M. rosenbergii* as omnivorous in food habit, feeding greedily on both plant and animal materials.[18,19,20]

The diet pattern of *S. argus* at various length group showed that there was a gradual shift in

diet from smaller sized (<70 mm) to larger sized fish (>70 mm). Stomach is enlarged and U shaped with high consumption of food. The main food of the smaller specimens consisted of different species of unicellular algae and detritus. The components of detritus were mud, sand, minute broken shells of molluscs and other inorganic matter. Fish scales, diatoms, copepods and fish eggs were also found. The percentage occurrence of algae (58.2–88.1%) and detritus (12.3–32.4%) were higher than diatoms (7.2–19.3%), copepods (0.8–28.3%), fish scales (1.2–9.1%) and fish eggs (0.7–5.3%) were also observed. Larger sized fish have the most diversified food items in their diet. Multicellular algae were the predominant food of the adult fish (>70 mm) throughout the period of observation. Algae (48.4–86.3%), detritus (12.4–46.9%), diatoms (8.9–28.3%), fish scales (2.8–15.9%), crustaceans (1.2–13.6%), fish eggs (0.2–11.3%), bivalves (1.1–8.2), copepods (0.7–16.3%), rotifers (0.4–5.2%) sea anemones (0.2– 4.9%), sponges (0.4–3.1%) and polychaetes (0.2–2.9%) were found in the gut contents.[21] This feed type can be correlated with higher amount of protein percentage found in our study.

Considering the diet pattern of three studied species, it is clear that *M. rosenbergii* are omnivorous and detritivorous, while *E. suratensis* are mostly detritivorous and *S. argus* are mostly herbivorous. Because of this reason carbohydrate and lipid content are highest in *M. rosenbergii* followed by *S. argus* and *E. suratensis*. The low values of carbohydrate recorded in the present study suggests that glycogen in many marine animals do not contribute significantly to the total reserves in the body.[22] This finding is similar to several other researchers. The species have a preference for surviving in brackishwater around 15 psu. However, in the present study, they seem to be adapted in the artificial tank where the salinity ranges from 3 – 5 psu.

The present research has great relevance from the climate change perspective as the freshwater ponds of Sundarban often encounter the problem of saline water intrusion due to tidal surges, high wave actions that mainly occur during the cyclonic depression period. Due to hike in salinity, these aquatic systems cannot be utilized for a considerable long period of time and the people face economic crisis. The present study is thus a road map of utilization of such ponds that can boost up the secondary production of the system and open an avenue of alternative livelihood for the island dwellers.

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