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Grow-out performance, length-weight relationship and variation in condition of all male Nile tilapia (*Oreochromis niloticus* Linnaeus 1758) from low saline fertilize earthen ponds of Indian Sundarbans

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Abstract

Grow-out performance, LWR and variation in condition of all male Nile tilapia *O. niloticus* (Linnaeus 1758) reared in low saline fertilize earthen ponds in Sundarbans, India were studied for 8 months (March to November 2015). The ponds were fertilized with organic and inorganic manure. Low input mastered oil cake and lime stone powder were applied @ 250 and 200 kg ha^{-1} in the both ponds respectively. All male Nile tilapia (1.58±0.06 g; 3.2±0.21 cm) added with stocked fishes @ 20000 fish ha^{-1} attained 210.41±8.28g (29.6±1.60 cm) while means specific growth rate and daily weight gain were 1.74±0.40% day^{-1} and 0.86±0.14 g day^{-1} respectively. Exponent value of length-weight relationship ($W=0.006TL^{2.984}$) indicated isometric growth of tilapia fish having constant body shape with proportionate increase in length and weight. There was the monthly variation in K values with the highest mean value of 0.84 in May when the fishes were grown and lowest mean value of 0.68 in March when the fishes were much smaller. This infers that fish juveniles were grew well better plumpness than smaller ones and provision of any low cost supplementary feeding is essential after attainment of certain size to produce good plumpness all male Nile tilapia in low saline earthen pond farming.

Keywords: *oreochromis niloticus*, growth, length-weight relationship, condition factor, sundarban

Introduction

Tilapias, indigenous to Africa are members of the family Cichlidae and are the most widely produced fishes in the world, ranked second only in importance in aquaculture global production to the carps (Ridha 2006; Fayeofori and Manuel 2013) [33, 15]. It is naturally distributed from the upper Nile river southwards to the equator and west to the Atlantic coast (Trewavas 1983) [40] while its introduced range has widened, covering atleast 85 countries of tropics, subtropics and temperate environments (Lowe *et al.,* 2012) [26]. Tilapia has been considered as the Food Fish of the 21st century and is popularly known as aquatic chicken. The Nile tilapia, *Oreochromis niloticus* (Linnaeus 1758), are highly successful invaders is a widely cultured species of World because it grows and successfully reproduces in a wide range of environmental conditions and tolerates stress induced by handling (Tsadik and Bart 2007; Lowe-McConnell 1958) [41, 25].The efficiency of reproduction in tilapia has paradoxical consequences. This aptitude allows easy and rapid propagation of the fish in various environmental conditions, but can as well be a source of problem. Within a limited environment, uncontrolled multiplication of the fish not only reduces the faunal diversity of the system but also produces dwarf fish population of poor market value (Coleman 2001; Hepher and Pruginin1981) [12, 18]. Commercial tilapia production generally requires the use of male mono sex populations. All male Nile tilapia grows approximately 30% as fast as the females. Moreover, the presence of female tilapia leads to uncontrolled reproduction, excessive recruitment of fingerlings, competition for food and stunting of the original stock, which may not reach marketable size. All male culture of tilapia is postulated to solve this problem and dietary supplementation of synthetic androgens (17α-methyl testosterone) during early stages of development is a potent method for production of all-male tilapia population (Macintosh *et al.,* 1985; Gale *et al.,* 1999; Beardmore *et al.,* 2001; Smith and Phelps 2001) [27, 17, 4, 36].The predominant advantage of all male culture can be achieved in such aquaculture situations where one sex displays marked growth superiority, as in tilapia (Beardmore *et al.,* 2001) [4]. Thus, culture of all male tilapia might prove effective to induce a positive approach towards tilapia culture in India. Nile tilapia production occurs primarily in semi-intensive ponds using fertilizers to increase fish yields at low levels of production (Liti *et al.,* 2005) [24]. The fish can form a readily available source of animal protein in the diets of rural and urban dwellers belonging to the lower.

Growth performance of fish is one of the most important criteria for selection as a candidate species for farming. Length-weight relationship and condition factor provide basic information to the producer with an evaluation of the specific conditions under which organisms are growing (Araneda *et al.,* 2008) [3]. Length-weight relationship (LWR) of fish also plays a significant role in studying the growth, rate of feeding metamorphosis, fatness, onset maturity, gonadal development and general well-being of the fish population (Le Cren 1951; Pauly 1993) [23, 31]. Whereas condition factor (K) is a quantitative parameter estimated base on length-weight data, indicates the state of well-being of the fish for determining the present and future population success by its influence on the growth, reproduction and survival (Hossain *et al.,* 2006) [19].

Though exotic, Nile tilapia has been widely introduced in the shallow and seasonal ponds of eastern region of India (Sugunan1995) [37]. It is rapidly gaining popularity among the fish farmers as a readily available source of animal protein in the diets of rural and urban dwellers belonging to the lower socioeconomic strata (Chakraborty and Banerjee 2010) [9]. Only a few published data on grow out performance of androgen treated all male *Oreochromis niloticus* in the Indian context is available (Pandian and Varadaraj1998) [29] and again increase in yields can result from the development and adoption of new technologies and improved farming operations (Coelli 1995) [11]. Beside few report on growth performance, LWR and K of all male Nile tilapia reared in freshwater (Ronald *et al.*, 2014; Ferdous *et al.*, 2014) [34, 16] and in brackishwater were available (Tahoun *et al.*,2013) [38]. There is scarcity of information on growth, LWR of the species from low saline ponds of Sundarbans in spite of being a highly growth potential and ecologically important area where *O. niloticus* is abundantly available and forms a commercially important exotic species. This study aimed to assess grow out performances, LWR and variation in condition of all male Nile tilapia *O. niloticus* in low saline earthen ponds of Indian Sundarbans.

Material and methods

The present study was carried out during experimental farming of all male Nile tilapia (*Oreochromis niloticus* L.) in the Sundarban region of West Bengal for the period of March to November 2015. Nursery reared all male tilapia seeds (1.58±0.06 g, 3.2±0.21 cm) collected from a reputed hatchery at Naihati, North 24 Parganas and West Bengal India, were stocked in two brackishwater earthen ponds of 350m^2 each of Madhabnagar village (Lat. 21.787003–21.791785^{0}N, Long. 88.353365–88.356938^{0}E), Patharpratima block, South 24 Parganas, West Bengal, India (Fig 1). Initially, two ponds were completely dewatered, dried on sunlight and leveled. Then the ponds were limed at 200 kg ha $^{-1}$maintaining water level at 30 cm. The ponds were fertilized with application of cattle dung, urea, and single super phosphate at the rate of 500, 30 and 30 kgha^{-1} respectively during pond preparation. After completion of liming and fertilization, the pond water levels were increased to about 1 m. Any commercial pellet fish feed was not applied in the ponds. Then the fry were acclimatized and released in the two ponds at stocking densities of 20000 numbers ha^{-1}. The fishes were grown under natural productivity of fertilized ponds. Low input watered Mastered oil cake was applied @ 250kg ha^{-1} in the both ponds. Both fish and water samples were collected monthly during morning in between 08.00 to 09.00 hours and carried to laboratory in ice boxes for subsequent analysis.

Fig 1: Location of two low salinewater ponds (●) of Madhabnagar village at Pathapratima block in Indian Sundarban.

Fifteen fishes from each two ponds were collected during first week of each month i.e. 30 fish in a month and total 240 fish in the whole study period were collected and analyzed. Gravimetric data, namely, total length (TL, cm) was recorded with a slide caliper, while body weight (W, g) was measured using a digital electronic balance. Daily weight gain (DWG) was calculated using following the formula:

$$DWG = \frac{W_f - W_i}{t}$$

Where W_f and W_i are the average final and initial weight in time *t*.

Specific growth rate (SGR) was calculated using the conventional equation:

$$SGR = \frac{\ln w_f - \ln w_i}{t} \times 100$$

Where W_f and W_i are the average final and initial weight in time *t*.

The mathematical relationship between length and weight was calculated using the conventional formula (Pauly 1984) [30]:

$$W = a.TL^b$$

Where *W* is fish weight (g), *TL* is total length (cm), '*a*' is the

proportionality constant and '*b'* is the isometric exponent.
Fulton's condition equation was used to find out the condition factor (Chow and Sandifer 1991) [10].

$$K = \frac{\overline{w}}{(\overline{TL})^3} \times 10^2$$

Where K is the condition factor, $\overline{W}$ is the average weight (g) and $\overline{TL}$ is the average total length (cm) potential fit determination coefficient; n is the number of specimens recorded.

Water quality parameters viz. temperature, salinity, pH, dissolved oxygen (DO), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N) and phosphate-phosphorus (PO_4-P) of the pond water were analyzed following Standard Methods (APHA 1998) [2]. The water samples were collected between 08:00 and 9:00 hours at monthly interval. Water salinity was measured using a refractometer (ATAGO Japan). Planktons were collected using bolting silk plankton net (mesh size 64 µm) by filtering 100 L of pond water and concentrates were preserved in 5% buffered formalin for qualitative and quantitative analysis. One ml of concentrate was transferred to Sedgwick-Rafter counting cell in triplicate and phytoplankton constituents were identified and counted (Jhingran *et al.*, 1969; Prescott1961) [22, 32].

Differences of fish growth parameters were determined by analysis of variance with the General Linear Model procedure using SPSS for Windows v.17.0 programme (SPSS Inc Chicago IL USA). Duncan's Multiple Range Test (Duncan 1955) [13] was used. All data in the paper are expressed as mean ± standard deviation (S.D).

Results

The water quality parameters of two trial ponds are presented in Table 1. Water temperature recorded wide range with higher in May and lower in November. Dissolve oxygen (DO) values were ranged 6.04 to 8.96 mg L^{-1}that difference among the ponds. Salinity variation was wide range in three experimental ponds throughout the culture duration and was highest during summer (May) and lowest during rainy season (August).Monthly numeric Percentage occurrences of Planktonic concentration both phytoplankton and zooplanktons were showed in Fig 2. Chlorophyceae, Bacillariophyceae, Myxophyceae, Euglenophyceae are considered as the dominant phytoplankton in water. Among zooplankton groups, insect larvae, copepods, rotifers, cladoceran, polychaetes, fish larvae and shrimp larvae are the major parts in ambient water. Planktonic concentration of water was higher in Pond 1 than pond 2.

Table 1: Physico-chemical and biological parameters of low saline earthen ponds of Sundarbans

Water parameters	Pond 1	Pond 2
Water temperature (ºC)	18.7–32.5 (29.5±3.72)	18.5–32.5 (29.0±2.37)
pH	7.85 − 8.85 (8.09±0.23)	7.58−8.02 (7.78±0.31)
DO (mg L^{-1})	6.08 − 8.76 (6.06±0.65)	6.04 − 7.9 (6.99±0.52)
Salinity (ppt)	1.02 − 5.33 (4.87±0.19)	0.80−5.21 (2.98±.45)
Total Alkalinity(mg L^{-1})	140.32−180.54 (168.9±12.25)	140.59−185.03(165.9±10.51)
NO_2-N (µg L^{-1})	12.93 − 24.47 (17.55±5.83)	12.39−22.45(18.91±5.62)
NH_4-N (µg L^{-1})	21.82−40.08(30.76±5.61)	22.82−45.08 (33.19±7.91)
NO_3-N (µg L^{-1})	69.62−111.09 (93.12±15.41)	67.98−105.04 (92.66±11.14)
PO_4-P (µg L^{-1})	21.58−45.27(32.07±13.43)	19.89−43.27 (33.98±10.98)
phytoplankton (numbers L^{-1} ×10^3)	14.30−16.06 (15.89±1.62)	14.50−16.00 (15.12±1.94)
Zooplankton (numbers L^{-1}×10^3)	2 − 3.89 (3.49±0.25)	2 − 4.35 (2.98±0.23)

*Values indicate range; mean±SD of different parameters

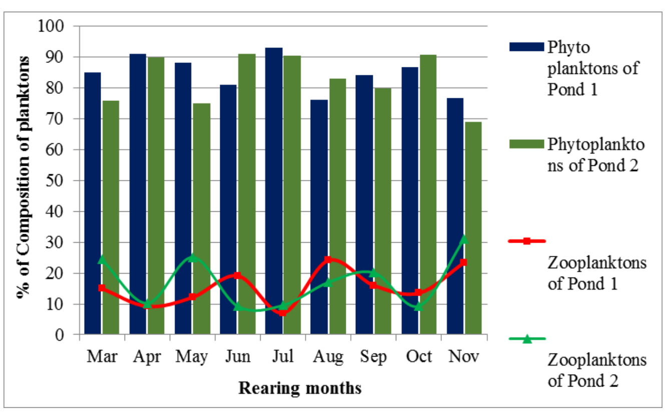

Fig 2 Percentage occurrences of planktons in low saline earthen ponds of Sundarban.

Growth performance of all male Nile tilapia in terms of final length (cm) and weight (g) is presented in Fig 3. After 240 days of rearing all male Nile tilapia grown were from 1.58±0.06 g(3.2±0.21 cm) to 210±8.28g (29.6±1.60cm).Daily weight gains (DWG) ranged between 0.22 during initial month of rearing and 1.46 g day^{-1} in full juvenile stage while mean value was recorded to be 0.86±0.14 g day^{-1}(Fig 4). Average Specific growth rate (SGR) calculated was 1.74±0.40 % day^{-1} which ranged between 0.37(November) and 3.52% day^{-1} (March). Length-Weight Relationship (LWR) showed curvilinear growth pattern in Fig 5. When the exponent value (b) is equal to 3, the fish growth is called isometric and when it is lesser or greater than 3, it is called allometric (Enin 1994) [14].The exponential value (b) of LWR was recorded to be 2.99 indicating isometric growth of fish. The growth of Nile tilapia was isometric in the present culture. The Fulton's condition factor (K) of fish fingerlings was ranged between 0.68 in March to 0.84 in May while mean value of K was 0.78±0.02 (Fig 4).The higher values were observed in the fishes of 14.4 − 18.6 cm (25.51 − 50.33 g) size and the most small fishes of 3.2 -8.5 cm(1.58-3.50g) size exhibited lower values.

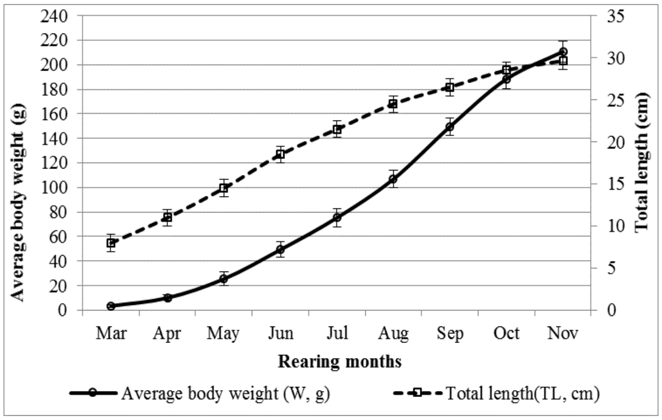

Fig 3: Growth of *O. niloticus* reared in low saline earthen ponds of Sundarban

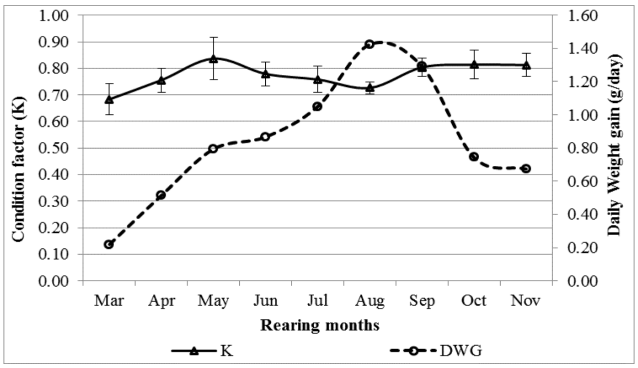

Fig 4: Daily weight gain and condition factor of *O. niloticus* reared in low saline earthen ponds of Sundarban

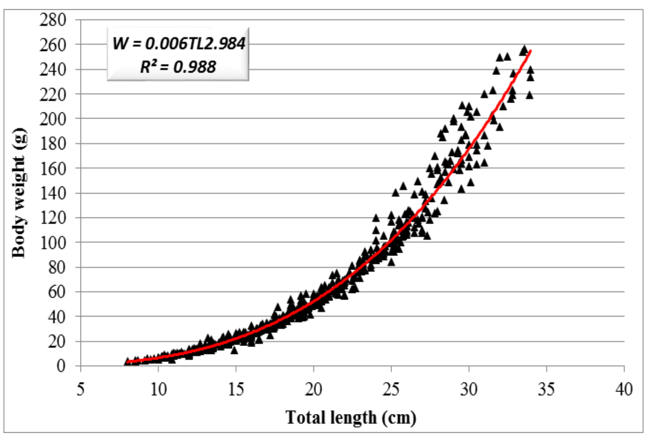

Fig 5: Length-weight relationship of *O. niloticus* reared in low saline earthen ponds of Sundarban.

Discussion

Fish food consumption might be influenced by many environmental factors such as water temperature, food concentration, stocking density, fish size and fish behavior (Houlihan *et al.*,2001) [20]. Different physicochemical parameters of water like temperature, DO, free CO2, transparency and pH are generally considered to have primary importance in fish culture (Islam *et al.*, 2006) [21]. The Recorded water quality parameters were within optimum ranges for brackish water aquaculture and differed significantly ($P<0.05$) with time in present study (Chakrabarti *et al.*, 2002; Bhowmik *et al.*, 1992) [8, 5].The optimum temperature for tilapia culture is reported to be 20-30°C or above (Islam *et al.*, 2006) [21]. The ideal DO level for tilapia culture is 4-5 mg/l and the present study showed higher DO values for both ponds attributing good environment for tilapia culture. Though the salinity regime is low in culture pond but tilapia can tolerate wide range 1-15ppt.The optimum pH of for tilapia culture is reported to be 7.91-8.03 (Tahoun *et al.*, 2013) [38].This is the common seasonal salinity fluctuation of the brackishwater in the Sundarban region (Moriarty 1976) [28]. The water pH level of present study was almost similar ranges that suggested the good water condition for sufficient grow to the fish. Concentrations of toxic gases like nitrite-nitrogen (NO2-N)and ammonia-nitrogen (NH4-N) remained lower than the critical level and concentrations of nutrients like nitrate-nitrogen (NO3-N) and phosphate-phosphorous (PO4-P) was much lower than fertilized ponds reported from Sundarban (Biswas *et al.*,2012; Saha *et al.*, 2001) [6, 35].

Growth potential of a fish species is one of the most important criteria for selection as a candidate species. Available reports regarding growth performances of all male tilapia is highly variable from different farming trials. As no information is available on growth, LWR and K of *O. niloticus* in low salinewater, it is not possible to compare the present findings on growth with previous reports. Being low stocking and fingerling, much higher growth in Nile tilapia monoculture in brackishwater (5-15 ppt) fed pond compared to the present study has been reported where 20.5±0.30 g Nile tilapia fingerlings attained 321.6±2.2 g with ADG of 1.7 gday-1 in 180 days at stocking of 40000nos ha^{-1}(Tahoun *et al.*, 2013) [38]. Higher growth was also reported where the tilapia fingerlings (35.15±0.35g, 13.3±0.23cm) attained 309.6±2.6 g (25.4±0.2cm) at stocking density 20000 numbers ha^{-1} in 90 days from freshwater fertilized fed pond of West Bengal (Chakraborty and Banerjee., 2010) [9]. In mola-chela-puti-mono-sex tilapia polyculture trials, all male tilapia (*O. niloticus*) performed lower growth was reported at stocking density of 0.56 fish m^{-2} where fishes were grown from 5.12±0.34g to 242.42±17.4g (ADG: 0.376g day^{-1}) in 630 days in earthen fertilized ponds of Bangladesh (Ahmad *et al.*, 2010) [1].Though it is a non fed farming the grow-out performance of all male tilapia was better in low saline fertilized earthen pond at Sundarban. The relationship between fish length and gut length ranged from 2.9 to 3.4 and it was similar for 25 g to 125 g weight classes in fertilized earthen ponds where LWR is exponential (r^2= 0.9862) (Tawwab 2011) [39]. The isometric exponent (b=2.984) of length weight relationship in the present study indicated isometric growth condition of tilapia. Condition factor is expressed to compare the ‘condition’, ‘fatness’ or ‘well being’ of fish and are based on the hypothesis that the heavier fish of a given length are in better condition (Biswas *et al.*, 2011) [7]. Isometric growth and good condition factor (K= 0.77±0.02) of Nile tilapia in the present study indicates sufficient of food materials present in the farming system as no competition for space is likely in such optimum density and production systems. Although growth, LWR and Condition for this species from different location of globe are available in Fish Base but the present information will be the first report from the core Sundarban region of West Bengal, India.

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