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Potential Effect of Different Stocking Density Levels on Growth Performance and Survival of Climbing Perch, *Anabas testudineus* (Bloch, 1792)

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Abstract

Anabas testudineus (Bloch, 1792), the climbing perch, popularly known as *koi,* is an obligate air breathing fish, inhabiting fresh and brackish waters of Southeast Asia. A study was conducted in 12 circular cement cisterns, each of 518-liter capacity, to evaluate the effects of stocking density on growth performance and survival of climbing perch (*Anabas testudineus*). Stocking density is one of the key variables influencing growth, survival and production levels of a fish species. Four different stocking densities of *koi* (treatments) were compared viz, 10 (T_1), 20 (T_2), 30 (T_3) and 40 (T_4) numbers/ 0.5 m^3 volume of circular cistern. Each stocking density was studied in triplicate. Formulated pellet feed of 20% protein content was fed twice daily at 5 % of the body weight. Growth response and water quality parameters of fish were monitored at fortnightly intervals. The duration of the study was four months. On termination of the study, the final average weight in the four treatments were 73.34 g in T_1, 57.13 in T_2, 42.20 g in T_3 and 23.86 g in T_4. Growth in terms of average length (cm), length gain (cm), average weight (g), weight gain (g), average daily growth (% ADG), and specific growth rate (% SGR) was higher in the first treatment (T_1) as compared to treatments, T_2, T_3 and T_4. The higher SGR % of 3.01 was recorded in treatment T_1 and the lowest of 2.05 in treatment T_4. The best FCR of 1.83 was intreatment T_1, while the poorest FCR of 5.98 was in treatment T_4. The FCE % ranged from 54.61 in T_1 to 16.70 in T_4. Increasing the stocking density could result in a stress condition, linked to social interaction, which in turn, leads to reduced food intake, poor feed utilization and consequently poor growth. The results revealed that stocking density had a significant effect on growth performance of climbing perch. Lower stocking densities of *koi*, favored better growth and production.

Keywords: Stocking Density levels of Climbing Perch

Introduction

The burgeoning population, the world over, depends to a very large extent on the culture-based fisheries sector, for addressing the crucial, food insecurity issues. In India, the fisheries sector is integrally linked with employment generation, income augmentation, foreign exchange earnings, as well as providing food and nutrition security to millions of people (Ayyappan, 2006). Concurrently, it also an inseparable part of life, for a wide section of socially backward people of the country (Kumar et al., 2003). India is the second largest farmed fish producer in the world, with an estimated area of 2.48 million ha of ponds and tanks. It is estimated that the country produced about 7.7 mmt of farmed fish during 2018-19, with the fresh water aquaculture contributing about 80 percent of the total aquaculture production of the country (NFP, 2020). In fresh water aquaculture, the major cultivable fish species of India are Indian major carps, pangas, chinese carps, common carp and tilapia (Adhikary et al., 2009). Of late, increased attention is being given to the culture of air breathing fishes, like the climbing perch (*Anabas testudineus),* singhi (*Heteropneustes fossilis)* and magur (*Clarias batrachus*). Fresh water fish, is of much importance to the national economy, as a major source of protein, essential minerals, vitamins, and unsaturated fats (Alam et al., 2012). The climbing perch (*Anabas*

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testudineus) or *koi* is considered an economically important fresh water fish species, fetching a high market valueand having a superior nutritional profile. In addition to having good consumer demand, *koi* with stands higher stocking density and possesses a high capability for stress tolerance. The added advantages of air breathing ability and enhanced tolerance of adverse environmental conditions, make *koi* a favoured candidate for fish culture. Climbing perch is considered as a valuable item, in diets for the sick and the convalescing. This fish contains high values of physiologically available iron and copper, essentially needed for haemoglobin synthesis (Saha, 1971). In aquaculture, stocking density is one of the most important variables, as it directly influences survival, growth, behavior, health, water quality, feeding and production (De Oliveira, 2012). An increase in stocking density, leads to enhanced energy requirement, induced by stress (Leatherland & Cho, 1985) resulting in reduced growth and poorfeed utilization efficiencies (Hengsawat et al., 1997).

Growth performance of fish largely depends on the consumption of feed, as well as its assimilation and conversion into body tissues (Brett & Groves, 1979; Burel et al., 1996). The use of high stocking density, as a technique to maximize production from available water areas, has been shown to affect growth of fish, often adversely. In many cultured fish species, growth has indirect relationship to stocking density and this observation is mainly attributed to social interactions (Holm et al., 1990; Haylor, 1991; Ma et al., 2006). Social interactions as a result of competition for food and for space can negatively affect fish growth. On the other hand, the fish price is influenced by the market requirement such as size and production, which depends on their growth. In modern day commercial aquaculture, the stocking density is an important indicator that determines the economic viability of the production system (Ellis et al., 2002). The present study was undertaken to assess the growth performance of climbing perch (*Anabas testudineus*) at four different stocking densities, when reared in circular cement cisterns.

Materials and Methods

The present study was conducted for a period of four months (120 days) in the wet lab of the Department of Aquaculture, Kerala University of Fisheries and Ocean Studies, Panangad. The acclimatization tanks and experimental cisterns were arranged in the indoor section of the wet lab. Prior to initiation of the study, the acclimatization tank and cement cisterns were disinfected with 5 ppm potassium permanganate and washed thoroughly and dried for a day. Borewell water was aerated and used to fill the experimental tanks. Aeration was also provided in the tanks. Four hundred (400) numbers of *Anabas testudineus* fingerlings were procured from a reputed fish hatchery (Pulimugham Aqua Farms and Hatcheries, Alappuzha). The seed was transported to the wet lab, in ten polyethene bags, under oxygen packing. On arrival at the wet lab, these bags were kept a float in acclimatization tanks, for half an hour. Thereafter, the seed was gently let out into the acclimatization tanks. The seed was treated with salt solution (1 ppt) for 2 minutes, to eliminate any opportunistic bacteria / fungi, that could be present, as well as tominimize, the stress due to transportation. The seed was acclimatized to laboratory conditions for a week, prior to initiation of the study. Water quality was maintained by partial exchange as required. Ad libitum feeding was done with commercially available pelleted feed over the period of acclimatization.

Healthy uniform sized individuals were selected from the acclimatized seed, for the study. The selected individual seed averaged 4.0 cm in length and 2.0 gm in weight. Completely randomized block design was selected for the study. The experimental setup consisted of 12 uniform sized circular, cylindrical type, cement tanks each having capacity of 0.518 m^3, with dimensions of 1.05 m outer diameter, 1 m inner diameter and 0.66 m height. There were four treatments, each having three replications. The present study was taken up to study the effect of four different stocking densities, viz., 10, 20, 30, 40 (T_1, T_2, T_3, T_4) numbers / 0.5 m^3 on the growth of *Anabas testudineus* fingerlings. The cistern was covered with netting to prevent the fingerlings, leaping out of the cistern. Feeding was done *ad libitum* with formulated feed (Feed code – 152034, Feed no – 5, die size 4 mm) was purchased from 'Growel Feeds Private Limited', with overall protein content of 20 %, twice a day. The nutrient composition of the feed is given in Table 1. The feed was provided ineach experimental tank, @ 5% of the body weight of the fish stocked, twice daily. The quantity of feed given was readjusted after each fortnightly sampling.

Sampling was done at fortnightly intervals to assess the growth of fishes. At each sampling, fishes

Table 1. Proximate composition of feed

Component	Level (%)
Crude Protein	20
Crude Fat	3.0
Crude Fiber	8.5
Moisture	11

stocked in each tank, were collected using a hand scoop net and individual length and weight measured and recorded. The length and the weight of the experimental fishes were measured by using measuring scale and electronic weight balance respectively. The parameters used for evaluation of growth were average gain in weight, average gain in length, average percentage weight gain, average percentage length gain, specific growth rate (SGR), average daily growth rate (% ADG), feed conversion ratio (FCR) and feed conversion efficiency (FCE). Growth parameters were computed using following formulae.

Calculation of fish growth parameters:

Average weight (g) = Average final weight (g) – average initial weight (g)

Average length (cm) = Average final length (cm) – average initial length

Weight gain (%) = [Final weight (g) – Initial weight (g) / Initial weight (g)] ×100

Length gain (%) = [Final length (cm) – Initial length (cm) / Initial length)] × 100

W_1= Initial weight of animal (g) W_2= Final weight of animal (g)

ADG (%) = [W_2 (g) – W_1 (g) / W_1 (g) × Time interval of experiment] ×100

SGR (%) = [In (w2) – In (w1) / Time interval in days] × 100

Where,FCR = Total amount of feed intake (g) / Total weight gain (g)

FCE (%) = [Total weight gain (g) / Feed intake on dry matter basis] x 100

Survival (%) = [Final number of fishes surviving/ Initial number of fishes stocked] x 100

The experiment was designed statistically using the Completely Randomized Design (CRD) with four treatments and three replications. All indices such as average length, average weight, length gain, weight gain, average daily growth rate (ADG), Specific growth rate (SGR), feed conversion ratio and feed conversion efficiency were subjected to statistical analysis. The significant difference between the treatments, was tested employing two-way analysis of variance (ANOVA), at 5% level of significance. Comparison of mean values in pairs, was done using Duncan's multiple range test (DMRT) (Zar, 2003). All the statistical analyses, were performed using the software programme IBM SPSS (Version 20).

Results and Discussion

In the present study, *Anabas testudineus* recorded the highest average gain in weight of 71.34 g in T_1 with 10 number of stocking density/ cistern and the lowest average gain in weight of 21.86 gm in $T_{4,}$ with 40 number of stocking density/ cistern, overthe study period of 120 days (Table 2). The results indicated that the weight gain had an inverse relationship, with the stocking density of fishes. According to Backiel & LeCren (1978) stocking density is an important parameter directly influencing, the growth of fish, as well as the production. Rahman et al. (2013) observed higher growth rate in *koi* raised at lower stocking density. On termination of the study, at the end of 4 months, the average final weights attained by climbing perch, in the different treatments were T_1 (73.34 gm), T_2 (57.13 gm), T_3 (42.20 gm) and T_4 (23.86 gm). The corresponding lengths recorded were T_1 (16.76 cm), T_2 (13.63 cm), T_3 (11.73 cm) and T_4 (10.26 cm) respectively (Table 2; Fig. 1.&2).

Studies indicate that stocking density does have an impacton the growth performance of climbing perch. Kohinoor et al. (2007) stocked *koi* at three different stocking densities, of 75,000, 1,00,500 and 1,25,000 ha in their on- farm trials, and recorded highest growth at the lowest stocking density. The studies conducted by Kohinoor et al. (2009), of the three stocking densities tested, viz., 50,000, 56,250 and 62,250 numbers of *koi* / ha, the lowest stocking density of 50,000, was found to lead to the highest average weight. Jannat et al. (2012) observed all growth parameters to be superior, in the case of pond raised climbing perch, stocked at lower densities. Roy et al. (2013) assessed the growth of

Table 2. Multiple comparisons for testing the homogeneity of different growth parameters (Mean ± SD) between treatments (Duncan's MRT) after 120 days

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Initial weight (g)	2 ± 0.00[a]	2 ± 0.00[a]	2 ± 0.00[a]	2 ± 0.00[a]
Initial length (cm)	4 ± 0.00[a]	4 ± 0.00[a]	4 ± 0.00[a]	4 ± 0.00[a]
Final weight (g)	73.34 ±0.020[a]	57.13 ± 0.015[b]	42.20 ± 0.015[c]	23.86 ± 0.025[d]
Final length (cm)	16.76 ± 0.152[a]	13.63 ± 0.251[b]	11.73 ± 0.057[c]	10.26 ± 0.115[d]
Weight gain (g)	71.34 ±0.020[a]	55.13 ± 0.015[b]	40.20 ± 0.015[c]	21.86 ± 0.025[d]
Length gain (cm)	12.76 ± 0.152[a]	9.63 ± 0.251[b]	7.73 ± 0.057[c]	6.26 ± 0.115[d]
Specific growth rate (SGR) (%)	3.01 ± 0.010[a]	2.78 ± 0.005[b]	2.54 ± 0.005[c]	2.05 ± 0.010[d]
Average daily growth (ADG) (%)	29.72 ± 0.010[a]	22.97 ± 0.005[b]	16.75 ± 0.010[c]	9.10 ± 0.011[d]
Feed conversion ratio (FCR)	1.83 ± 0.010[a]	2.37 ± 0.010[b]	3.25 ± 0.010[c]	5.98 ± 0.010[d]
Feed conversion efficiency (FCE) (%)	54.61 ± 0.141[a]	42.16 ± 0.052[b]	30.74 ± 0.020[c]	16.70 ± 0.020[d]
Survival rate (%)	100 ± 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]
Production (g/0.5 m^3/ 120 days)	733.4 ± 0.020[a]	571.3 ± 0.015[b]	422.0±0.015[c]	238.6 ± 0.025[d]

*Treatments with different superscripts are significantly different (P <0.05)

the Thai *koi*, *Anabas testudineus*, at three different stocking densities, viz., 550, 400 and 350 fry/ dec, and noted that the lowest stocking density led to the highest growth response.

Ahmed et al. (2014) conducted a comparative growth study of Vietnam *koi* and Thai *koi*, in which the growth of both species was better at lower stocking densities, whereas, production was enhanced at higher stocking densities. Several studies on the impact of stocking density on the growth of *koi,* are in agreement with the observation that, growth is inversely related to the stocking density. This in turn, is attributed to social interactions (Rahman & Marimuthu, 2010; Rahman & Monir, 2013; Rahman et al., 2013; Ahmed et al., 2015). The study of Chakraborty & Nur (2012) revealed that the survival, growth and production in polyculture and monoculture systems, were inversely related, to the stocking densities of fingerlings. In majority of the studies, conducted on the rearing of *Anabas testudineus* in cage culture systems, low to moderate stocking density was found to be more appropriate. These studies however, mainly focused on production and economics of the targeted speciesthan on the growth performance (Ali et al., 2015; Habib et al., 2015; Uddin et al., 2016).

Specific growth rates are indicative of the average rate of growth, over the period of study. In the present study, *koi* fingerlings showed the highest specific growth rate of 3.01 % in T_1 and the lowest specific growth rate of 2.05 % in T_4 (Table 2 &

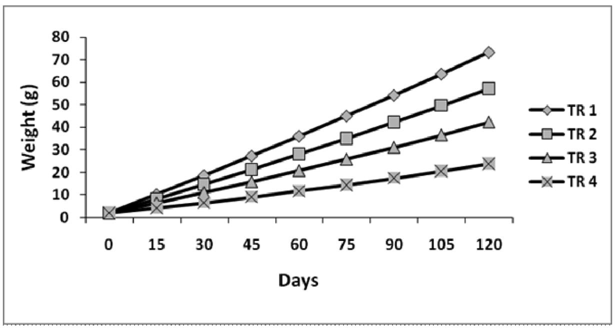

Fig. 1. Average final weight (g) of *Anabas testudineus* fingerlings in different treatments

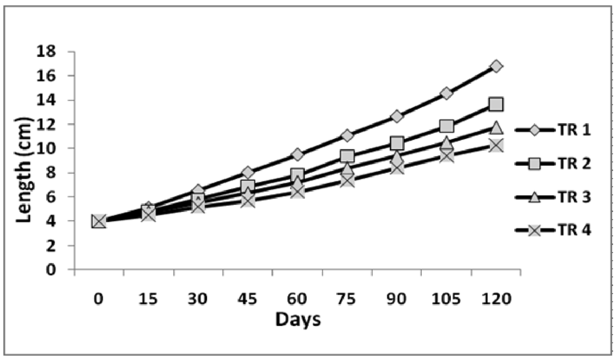

Fig. 2. Average final length (cm) of *Anabas testudineus* fingerlings in different treatments

Fig. 3). This indicates that the higher specific growth rate in T_1 is directly related to the enhanced growth performance, while the lower value in T_4 is reflective of the reduction in growth, at the higher stocking density. In the present study, % SGR was the highest (3.1) in the lowest stocking density tried. With increase in stocking density, a progressive decline in SGR was observed. The SGR in T_2 and T_3 treatments were 2.78 % and 2.54 % respectively. The lowest value of 2.05 %, was obtained in the highest stocking density tried (T_4). Kohinoor et. al. (2009) recorded % SGR values of 2.68, 2.59 and 2.55 in *koi*, at stocking densities of 50,000, 56,250 and 62,250 / ha, respectively. The inverse relation observed between stocking density and SGR %, are comparable to that reported in other studies (Jannat et al., 2012; Rahman & Marimuthu, 2010; Rahman et al., 2013; Roy et al., 2013; Ahmed et al., 2015).

The % average daily growth (ADG) of *Anabas testudineus* recorded in different treatments were 29.72 (T_1), 22.97 (T_2), 16.75 (T_3) and 9.10 (T_4) (Table 2 & Fig. 3). The significantly highest ADG value was obtained in treatment T_1 and the lowest value was obtained in treatment $T_{4,}$ which had *koi* stocked @10 and 40 numbers, respectively / cistern. In thepresent study, the ADG showed a negative correlation, with increase in stocking density. Similar findings have also been reported in studies conducted by Ali et al. (2015). They noted that the % average daily growth (g) of *Anabas testudineus* was 12.084 in T_1 treatment with 50 fry/m^3 followed by 11.975 in T_2 treatment with 75 fry/m^3 and 11.872 in T_3treatment with 100 fry/m^3 respectively.

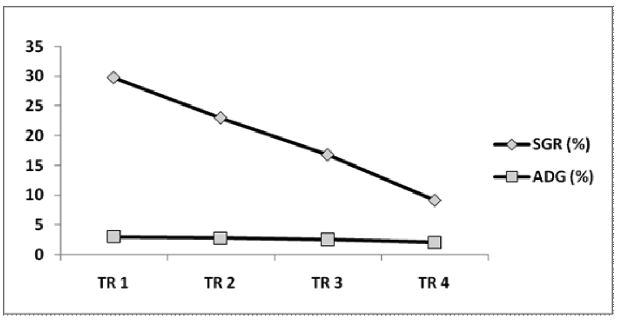

Fig. 3. SGR (%) & ADG (%) of *Anabas testudineus* fingerlings in different treatments

The FCR values attained in the different treatments were, 1.83 in T_1, 2.37 in T_2, 3.25 in T_3 and 5.98 in T_4 (Table 2 & Fig. 4). There was an increasing trend in FCR values from T_1 to T_4treatments, fish in all treatments, having beenfed a 20 % protein feed. As the stocking density increased, there was a progressive increase, in the amount of feed required, for unit gain in weight of fish. This was evidenced by the rising values of FCR, which is a clear indication, ofreduction in feed utilization efficiency, at higher stocking densities. Increase in stocking density was found to have a negative influence on FCR in the present study. Rahman & Monir (2013) reported that fish stocked at lower stocking densities showed a good FCR value of 1.63 in T_1 treatment stocked at 50,000/ ha; whilethe higher stocking density had a poorer FCR value of 2.90 (treatment T_3 stocked at 10,000/ ha), whenfed with 35 % protein feed.

Reduction in food conversion efficiencies of *koi,* at higher stocking densities has been noted by several researchers (Kohinoor et. al; 2009; Rahman & Marimuthu; 2010). Alam et. al. (2010) obtained better FCR of 2.88 in *koi*, fed adiet of higher protein content of 50.92 %, than on a diet of 20.60 % protein content (4.63). Variable FCR has also been reported in *koi,* by Phuong et. al. (2014) in their studies.They obtained FCR values of 6.13 in the case of *koi* fed a 20 % protein diet, 5.46 on a 25 % protein diet, and 4.06 on a 30 % protein diet. Uddin et. al. (2016) obtained FCR of 2.65 at a lower stocking density of 40 fish / m^3, while a higher stocking density of 100 fish / m^3, led to a FCR of 2.93, feeding being done with a 28.52 % protein diet. The FCR values reported in the present study are comparable with that of earlier studies, being the best (1.83), in the lowest stocking density assessed, indicating good utilization of feed. The relatively high FCR value obtained in the highest stocking density tried, is comparable to that observed in earlier studies and could be due to the incomplete digestion of food (Alam et al. 2010).

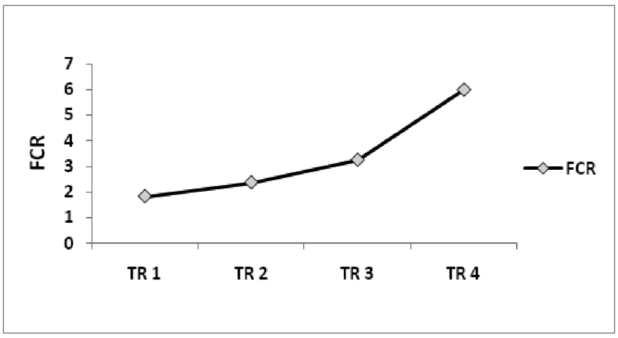

Fig. 4. FCR of *Anabas testudineus* fingerlings in different treatments

In this study, the highest % FCE was observed in treatment T_1 (54.61) followed by T_2 (42.16), T_3 with

(30.74) and the least in T_4 (16.70), (Table 2 & Fig. 5). The values obtained for feed conversion efficiency (FCE) are a reflection of the FCR values, since the FCE is the reciprocal of the FCR, expressed as a percentage. There was a declining trend in the value of FCE as the stocking density increased.

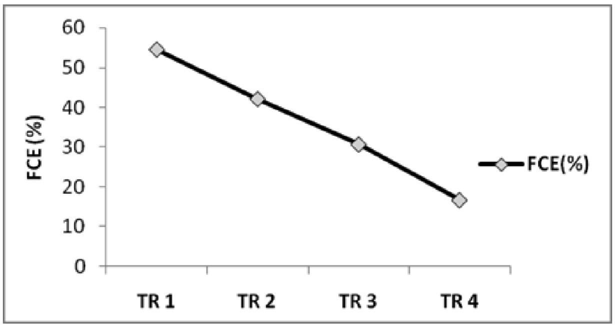

Fig. 5. FCE (%) of *Anabas testudineus* fingerlings in different treatments

Survival is one of the fundamental factors governing the fish production. The survival of fish depends on stocking density, availability of feed and physico-chemical conditions of water. in the present study, the survival rate of *Anabas testudineus* fingerlings was 100 %, in all the stocking densities assessed. Decrease in survival rate with increased stocking density has been reported by several authors (Jannat et al., 2012; Rahman & Monir, 2013; Kohinoor et al., 2009; Roy et al., 2013). However, in the present study, there was no significant difference in survival of *koi*, at different stocking densities. Besides, growth profile, feed utilization efficiencies and production values, were significantly higher in *koi*, raised at the lower stocking densities. This in turn, is indicative of the viability of rearing *koi*, at low stocking densities. However, rearing of *koi* at higher stocking density, could beof relevance, in the utilization of water bodies with suboptimal water quality.

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