ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2015; 3(1): 385-388

www.fisheriesjournal.com
Received: 16-07-2015
Accepted: 17-08-2015

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Optimization of stocking density of Vietnamese climbing perch in cage at coastal region

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Abstract
First growing strain of climbing perch Vietnamese koi (*Anabas testudineus*) seed was imported from Vietnam at 2012. Presently, this strain is getting more popularity than our native and Thai koi strain as the growth rate of Vietnamese koi is much higher. An experiment was conducted from 6 May to 6 September 2013 to optimize the stocking density of Vietnamese climbing perch in the cage at Patuakhali district. Nine cages were used for this experiment having size 2.5m × 1.8m ×1.3m. The experiment was designed into three treatments having three replications assigned into a completely randomized design with various stocking density. The stocking density of different treatments T_1, T_2 and T_3 were 50, 75 and 100 fry.m^{-3}, respectively. Mega floating koi feed was delivered at a rate of 3 to 10% body weight twice a day. There was no significance difference among treatments for different yield parameters of Vietnamese koi (p<0.05). Survival of fish was not significantly affected by the stocking density and ranged between 93.33 to 95.66%. The significantly (p<0.05) higher fish production (kg.m^{-3}) was found in T_3 (13.32 kg) compared to other treatments. A simple economic analysis of the Vietnamese koi cage culture showed that T_3 generated the maximum net profit Tk. 1052.02 m^{-3} in four month followed by T_2 (Tk. 793.96) and T_1 (Tk. 532.65). So the present study revealed that highest stocking density (100 m^{-3}) of Vietnamese koi is most suitable in terms of production and economics in cage culture.

Keywords: Stocking density, Vietnamese koi, cage and coastal region.

1. Introduction
Climbing perch or walking fish, member of the labyrinth fish family, adapted to living in oxygen-depleted water or on dry land. It is not related to the true perch. Labyrinth fishes are spiny-finned fishes of Africa and South East Asia, which have a labyrinthine chamber over the gills that enable them to absorb and retain atmospheric oxygen. Members of some species can remain out of water for several days and will even suffocate (drown) if held underwater. The climbing perch, *Anabas testudineus* of South East Asia, is brown and reaches a length of 10 inches (25 cm). Climbing perches travel in search of water when their ponds dry up; they walk with jerky movements, supported by the spiny edges of the gill plates and propelled by the fins and tail. They are said to climb low trees. Climbing perches are classified in the phylum Chordata, subphylum Vertebrata, class Osteichthyes, order Perciformes, family Anabantidae. Climbing perch is a new freshwater species for fish culture that has been developed recently in cage system. Vietnamese koi was first introduced in Bangladesh in 2012.
Cage culture is an aquaculture production system where fish are held in floating net pens. Cages are widely used in commercial aquaculture overseas and individual cage units come in all shapes and sizes and can be tailored to suit individual farmers needs. Cage units can be purchased through commercial outlets, but can also be made from readily available construction materials such as polypipe, wood or/and steel. Cages can be used in both freshwater and marine environments.
Cages are used as a form of farming in their own right within flowing or large bodies of water and can also be used in small pond fish culture to protect fingerlings in the initial stages of development. Small cages with a capacity of one cubic metre are suitable for fingerling production. The cage can hold up to 300 fish at a time. People grow fish in their local ponds using a simple fish cage known locally as a "hapa". A few young fish are put into each "hapa", which acts as their home, floating just below the surface of the pond. Cages can be made using a few cheap materials. Bamboo poles form an outer frame that is covered in netting. Inside is a

"Nursery" section for the younger, more delicate fish and floats are added at the corners. A cage is a very simple means of restraining fish in one place and it can be easily made using local materials. Cage design must incorporate certain physical properties including the ability to hold fish securely but, also to be within the financial means of the cage operators.

Population of our country is increasing day by day and this growing population needs more food. Still, there is an ample opportunity for increasing fish production by cage culture. In Barisal region still the fishers are practicing in traditional method. There is vast water resource including river, cannel and lake available in this area. Faculty of Fisheries of Patuakhali Science and Technology University, Bangladesh will be a centre of delivering cage culture knowledge among the fisheries community. So the present study was designed to optimize stocking density of koi in cage culture to get more profit.

2. Materials and methods

The experimental hapa were constructed before the start of the experiment. The hapa were rectangular in size and synthetic netting of mesh size 5.0 mm closed from all sides except the top. The synthetic net were fitted with bamboo by using rope and metallic wire. The trough shaped enclosures of synthetic netting materials were fixed on the inner side of the frame. The hapa were kept afloat in such a way that 0.61 m of structure remains below in water and the remaining 0.61 m were kept above water, so that fishes can get free access of sunlight and air. The sizes of cage were 2.5 m × 1.8 m ×1.3 m. All the prepared hapa were set into the Lalkamal pond at Patuakhali Science and Technology University (PSTU) campus. A top net was also used to minimize escapes because the cage is only a few centimeters above the water surface. A small opening was kept at the top part of the cage to allow feeding, sampling of fish, removal of waste and harvesting.

The experiment was designed into three treatment groups (group T_1, T_2, T_3) each having three replications based on stocking density. Hapa were randomly selected for three sets of trials. For convenience, the hapas were arbitrarily numbered by 1 to 9. The stocking density for different treatments T_1, T_2 and T_3 were 50, 75 and 100 fry.m^{-3}, respectively.

Fry of Vietnamese koi was collected from "Sornalata Agro Farm Limited", Trisal, Mymensingh, Bangladesh.

The size of the experimental fry was 1-2 cm. The fry was stocked in each nine cage as per experimental design after proper conditioning at morning.

Mega floating koi feed was used in this experiment. The experimental fish were fed in two times a day at 09.00 am and 5.00 pm. The quantity of feed was adjusted every 15 days at the rate of 50%, 40%, 30%, 20%, 10% and 5% on the basis of increase in the average body weight of the stocked biomass.

The culture potentiality on the growth under the different stocking density was assessed by recording the rate of growth in terms of gain in length (cm) and weight (g) of fish at fortnightly interval. The length and weight were recorded by randomly sampling of 10 fishes from each hapa by using a small seine net. Weight was taken with a digital top loading balance (TANITA-5 kg x 1 g) and length with a measuring scale. All the data were recorded in a note book and spread sheet and then finally calculated the average length and weight of fishes according to treatment in every sampling day.

Physico-chemical parameters like temperature, pH, dissolved oxygen (DO), ammonia and alkalinity of the pond water were measured twice a day at fortnightly interval. Temperature was recorded by using a celsius thermometer. Dissolved oxygen and pH were measured by portable digital DO meter and digital pH meter, respectively. Ammonia and alkalinity were measured by the respective test kit.

An economic analysis was performed to estimate the net profit from different treatments. The net return/profit was measured by deducting the gross income from the gross cost per hapa. The benefit cost ratio was also measured as a ratio of gross income to gross cost. A simple economic analysis performed to estimate the net profit. The cost of inputs was calculated on the basis of wholesale market price (2013). The cost of Mega floating koi feed was Tk. 50 kg^{-1}. The selling price for Vietnamese koi was estimated as Tk. 200 kg^{-1}.

The experimental data were statistically analyzed by one way ANOVA (Analysis of Variance) to see whether there were differences in different treatments. The means of different parameters were compared by Duncan's new multiple range test (DMRT) at 5% probability level (Zar, 2010) [29].

3. Results

3.1 Water quality parameters

Water quality parameters like pH, Temperature, Dissolved oxygen, ammonia and alkalinity were observed at fortnightly interval throughout the experimental period (Table 1.).

Table 1: Water quality parameters observed during the experimental period.

Date	Parameter				
	pH	Temperature (°C)	DO (mgl^{-1})	Ammonia (mgl^{-1})	Alkalinity (mgl^{-1})
06.05.14	7.2	31	4.56	0.27	92
21.05.14	7.1	31.5	4.30	0.29	89
06.06.14	7.3	31.5	4.70	0.28	85
21.06.14	7.4	30.8	4.87	0.28	88
06.07.14	7.3	30.4	4.92	0.27	90
21.07.14	7.1	30.1	5.0	0.26	92
06.08.14	7.4	29.8	4.87	0.24	89
21.08.14	7.3	29.5	5.3	0.23	93

3.2 Yield parameters

The Yield parameters of Vietnamese koi in terms of initial weight (g), initial length (cm), mean final weight (g), final length (cm), mean weight gain (g), % weight gain, average daily gain (g), specific growth rate (%day^{-1}), survival (%), FCR, yield (kg.m^{-3}) and net profit (Tk.m^{-3})) were calculated at the end of the experiment. The initial average weight and length of fry in different treatments were 0.25 g and 2.18 cm in T_1, 0.27 g and 2.21 cm in T_2 and 0.24 g and 2.17 cm in T_3. Mean final weight (g) and length, mean weight gain (g), % weight gain, average daily gain (g) and SGR (%day^{-1}) of Vietnamese koi in different treatments are presented in Table 2. There was no significance (p<0.05) difference among treatments for different yield parameters of Vietnamese koi (Table 2). Survival of fish was not significantly affected by the stocking density and ranged between 93.33 to 95.66%. The significantly (p<0.05) higher production and net profit was found from treatment T_3 having stocking 100 fish per cubic meter (Table 2.).

Table 2: Yield parameters (Mean ±SE) of Vietnamese koi among different treatments

Yield parameters	T_1	T_2	T_3
Mean initial weight (g)	0.25 [a]± 0.03	0.27 [a]± 0.04	0.24 [a]± 0.03
Initial length (cm)	2.18 [a]± 0.08	2.21 [a]± 0.10	2.17 [a]± 0.06
Mean final weight (g)	145.26 [a]± 12.26	143.98 [a]± 12.65	142.71 [a]± 15.80
Final length (cm)	20.35 [a]± 0.337	19.81 [a]± 0.30	19.06 [a]± 0.29
Mean weight gain (g)	145.01 [a] ± 12.23	143.71 [a] ± 12.22	142.47 [a] ± 12.23
% Weight gain	58004 [a]	53325 [a]	59363 [a]
Average daily gain (g)	12.084 [a]	11.975 [a]	11.872 [a]
SGR (%day^{-1})	5.30 [a]	5.23 [a]	5.32 [a]
FCR	1.93 [a]	1.96 [a]	1.97 [a]
Survival (%)	95.66 [a]± 4.37	93.80 [a]± 5.85	93.33 [a]± 2.33
Yield (kg.m^{-3})	6.94 [b]	10.12 [ab]	13.32 [a]
Net profit (Tk.m^{-3})	532.65 [b]	793.96 [ab]	1052.02 [a]

Figure in the same raw with different superscript are significantly different (p<0.05)

4. Discussion

4.1 Water quality parameters

The water temperature observed during the study period was 29.5 to 31.5 °C i.e. within the suitable range. Similar findings were reported by Alam *et al*. (1997) [3], Haque *et al*. (2004) [10], Asaduzzaman (2005) [5], Rahman (2005) [24] and Kunda *et al*. (2008a) [17]. Mollah and Haque (1987) [19] reported water temperature ranged from 26.00 to 32.44 °C in the pond of BAU campus, Mymensingh.

The dissolved oxygen content in the present experiment ranged from 4.30 to 5.30 mgl^{-1}. The dissolved oxygen in the present study was similar to the findings of Kohinoor (2000) [15], Ahmed (2004) [1], Ali (2004) [4], Fatema (2004) [9] and Asaduzzaman (2005) [5], Hossain *et al*. (2000) [13], Paul (1998) [22] and Kohinoor *et al*. (1998) [16]. Hoq *et al*. (1996) [12] recorded DO ranging from 4.0 to 5.9 mgl^{-1} in five prawn farmers ponds, which were suitable for fish culture.

The pH value recorded from the pond varied from 7.1 to 7.3 which was more or less similar to the findings of Akiyama *et al*. (1982) [2], Wahab *et al*. (1995) [28], Ahmed (2004) [1], Azim *et al*. (1995) [7], Ali (2004) [4], Fatema (2004) [9], Paul (1998) [22], Asaduzzaman (2005) [5] and Asaduzzaman *et al*. (2006) [6]. These values were also within the suitable range for fish culture.

The ammonia content in the present experiment ranged from 0.23 to 0.29 mgl^{-1}. Wahab *et al*. (1995) [28], Kohinoor *et al*. (1998) [16] recorded NH_3-N from 0.07 mgl^{-1} to 0.23 mgl^{-1} and 0.05 mgl^{-1} to 0.25 mgl^{-1}, respectively in ponds in the BAU campus, Mymensingh, which are similar to the present study. Therefore the concentrations of ammonia-nitrogen in the present study were more or less within acceptable limits.

The alkalinity observed during the study period was 85 to 93 mgl^{-1}. Rahman and Rahman (1999) [23], Rahman *et al*. (1999) [25], Rahman and Haque (1998) [26], Uddin *et al*. (2007) [27], Chowdhary *et al*. (2008) [8], Kabir *et al*. (2009) [14] and Mazid (2009) [18] found more or less similar results.

4.2 Yield parameters

The initial average weight and length of fry in different treatments were 0.25 g and 2.18 cm in T_1, 0.27 g and 2.21 cm in T_2 and 0.24 g and 2.17 cm in T_3. There was no significance (p<0.05) difference among treatments for different yield parameters of mean final weight (g) and length, mean weight gain (g), % weight gain, average daily gain (g) and SGR (%day^{-1}) of Vietnamese koi.

The value of mean final weight and length among different treatments ranged from 142.71 to 145.26 g and 19.06 to 20.35 cm, respectively. There is no available literature on Vietnamese koi. Noor (2005) [20] reported that Thai koi (*A. testudineus*) obtained length 14.66 cm and weight 57.22 g for 50 days experimental period with supplemental feeding. From the present study it was observed that the growth of Thai koi (*A. testudineus*) in hapa was lower than the present study. In present study the culture period was 120 days with complete artificial feeding.

The specific growth rate (%day^{-1}) in the present study was found between 5.23 and 5.32% day^{-1}. Otubusin and Ifili (2000) [21] announced that in hapa system, SGR of *Clarias gariepinus* was 5.72% day^{-1} in 42 days experimental period when fish was fed frozen maggot. This result was more or less similar with the present study. Hasan *et al*. (2010) [11] found SGR of Thai koi was 3.69 to 3.82 %day^{-1} during 90 days rearing period in hapa. So it was found that the growth performance of Vietnamese koi is better than Thai koi.

The food conversion ratio in different treatments ranged from 1.93-1.97. Hasan *et al*. (2010) [11] found FCR value of Thai koi was 3.11 to 3.99 during 90 days rearing period in hapa.

The survival rate of Vietnamese koi under different treatments ranged from 93.33 to 95.66%. Hasan *et al*. (2010) [11] obtained survival rate 73 to 83% of Thai koi during 90 days rearing period in hapa. Noor (2005) [20] found that survivable rate of Thai koi (*A. testudineus*) was 81.67% during 50 days experimental period with a handmade feed. So from the present experiment, it was found that the survival rate of Vietnamese koi is greater than Thai koi.

The highest fish production (kgm^{-3}) was found in T_3 (13.32 kg), followed by T_2 (10.12 kg) and T_1 (6.94 kg). A simple economic analysis of the Vietnamese koi cage culture showed that T_3 generated the maximum net profit Tk. 1052.02 m^{-3} in four month followed by T_2 (Tk. 793.96) and T_1 (Tk. 532.65).

From the above discussion, it can be said that growth performance of Vietnamese koi was not affected by stocking density. But highest stocking density (100 m^{-3}) of Vietnamese koi is preferable in case of production and economics. So from the results of present study it may be a recommended species for culture because of higher production of Vietnamese koi than Thai koi. Though Vietnamese koi is new to Bangladeshi farmers, so if farmers culture Vietnamese koi in case then it will be more profitable. For better understanding more research is needed.

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