Culture potential of Thai climbing perch (*Anabas testudineus*) in experimental cages at different stocking densities in Kaptai Lake, Bangladesh

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Abstract. A 90-day experiment was carried out to investigate the effects of stocking density on growth, survival and yield of Thai climbing perch (*Anabas testudineus*) in cages of Kaptai Lake, Bangladesh. Juvenile Thai climbing perch were stocked (initial length, 5.80±0.26 cm and initial weight, 4.20±0.62 g) in cages (3m × 3m × 2m each) at 40 fish m^{-3}, 60 fish m^{-3}, 80 fish m^{-3}, 100 fish m^{-3} denoted as T_1, T_2, T_3 and T_4, respectively in triplicates. Feeding was done at apparent satiation with a commercial semi-buoyant pelleted grower feed (28.52% crude protein) twice daily in all the treatments. Water quality parameters were within suitable ranges for fish production throughout the experimental period. After 90 days of culture, growth in terms of final length, length gain, final weight, weight gain (WG) and specific growth rate (SGR) and survival of fish was higher in T_1 than those from T_2, T_3 and T_4. However, fish from T_1 and T_2 showed no significant differences in final weight, WG and SGR. The best growth was found in fish from T_1, while the poorest growth was found in fish from T_4. SGR ranged between 2.24 to 2.52%/day, the highest SGR was observed in T_1 and the lowest SGR was observed in T_4. The feed conversion ratio (FCR) ranged between 2.65 and 2.93, the lowest value 2.65 was observed in T_1, whereas the highest value 2.93 was observed in T_4. Survival rate of fish ranged from 57% to 71%, the lowest value 57% was observed in T_4 and the highest value 71% was observed in T_1. The results demonstrated that T_2 (60 fish m^{-3}) could be recommended based on weight gain and SGR of Thai climbing perch in cages of lake environment.

Key Words: cage aquaculture, fish stocking, Thai climbing perch, growth performance, Kaptai Lake.

Introduction. Thai climbing perch (*Anabas testudineus*) is an important exotic fish species in Bangladesh (Hasan et al 2007). Thai strain was introduced in Bangladesh from Thailand in 2002 and is commonly known as Thai koi to distinguish from local strain (Kohinoor et al 2010; Hasan et al 2010). It has some special characteristics such as faster growth rate, accessory respiratory organs, shorter culture period (within 3-4 months marketable size) and higher survival rate (Kohinoor & Zaher 2006; Khatune-Jannat et al 2012). Due to high growth rate and better return compared to other species, marginal farmers are very much interested to culture it. Furthermore, it is also becoming a highly demanded fish day-by-day due to its high nutritional value, taste, faster growth and having ability to withstand harsh environmental condition (Alam 2006). The species is considered as a valuable food fish species and recommended as diet for the sick and convalescents as it contains high amount of iron, copper and easily digestible poly-unsaturated fats and many essential amino acids (Saha 1971; Kohinoor et al 1991).

Bangladesh is a riverine country enriched with vast fisheries resources. Among the inland open water bodies, Kaptai Lake with an area of 68,800 hectares plays a significant role in annual fish production of the country. The present annual production of Kaptai Lake is 9,017 metric tons, which is 0.26% of total annual fish production of Bangladesh (DoF 2014). Kaptai Lake is one of the important natural habitats and breeding grounds of indigenous fishes in Bangladesh. But in recent years, Kaptai Lake has been drastically degraded as a result of indiscriminate fishing practices, use of destructive fishing gear, siltation and erosion of river basins, application of pesticides and herbicide during rice cultivation in adjacent land. These factors have created a serious problem to genetic resources and thus some fish species became gradually endangered (IUCN Bangladesh 1998; Hussain & Hossain 1999). The production of commercially important fish species (*Labeo rohita*, *Catla catla*, *Cirrhinus cirrhosus* and *Labeo calbasu*) in Kaptai Lake has declined year after year (Alamgir & Ahmed 2008). Moreover, the vast water bodies of Kaptai Lake have yet not been properly utilized for fish culture due to lack of adequate knowledge and proper culture technology. To increase the fish production as well as conservation of natural fish population, development of suitable culture technology for Kaptai Lake is very essential.

Among the various culture systems, cage culture is more suitable at present context of Kaptai Lake. However, cage culture is comparatively a promising method of aquaculture, which has gained much popularity throughout the world due to huge advantages over the conventional method of fish farming. By integrating the cage culture system into the lake environment, carrying capacity per unit area could be enhanced because the free flow of current brings in freshwater and removes the metabolic wastes, excess feed and fecal matter from cages (Beveridge 1983).

Hasan et al (2010) carried out an investigation on the production of Thai climbing perch reared in nylon hapas in Bangladesh. Mondal et al (2010) compared the aquaculture of Thai climbing perch between cage and pond under three management systems in Bangladesh. Phuong et al (2006) studied integrated cage-cum-pond culture systems with climbing perch in cages suspended in Nile tilapia *Oreochromis niloticus* (Linnaeus 1758) ponds in Vietnam.

However, so far our knowledge, no study has been done yet to optimize the stocking density of Thai climbing perch in cages in lake environment. Such information is necessary for maximum utilization of resources of Kaptai Lake. Considering the above facts, the present study was undertaken to know the effects of different stocking density on growth, survival and production of Thai climbing perch in cages of Kaptai Lake, Bangladesh.

Material and Method

Study area. A 90-day experiment was carried out in Kaptai Lake from 9 January, 2014 to 8 April, 2014. The experimental site was at Baitush-sharaf, Rangamati sadar, near the Riverine Sub-Station of Bangladesh Fisheries Research Institute (Figure 1).

Cage construction and installation. Twelve (12) net cages were installed in experimental site and all of the cages were same size and same designed (Figure 2). The frames of cages were made by straight and rigid bamboo poles. Empty plastic drums of 250 liters size were used as cage float. Net cages, having an area of 3m × 3m × 2m made of knot-less plastic net (mesh size 1.1 cm) was installed. Net cages were hanged with cage frame (made of long size bamboo). Each cage was covered at the top with another piece of large mesh size (4.5 cm) net to prevent escape of fish by jumping and predation of birds. The whole structure was fixed with bamboo raft and tied with anchors at both side by nylon rope to facilitate easy floating of cages depending on water level.

Experimental design and fish stocking. Juvenile Thai climbing perch fry were collected from a local hatchery. After proper conditioning in lake water for 24 hours, fries were stocked randomly in cages at early morning of the following day according to prior fixed stocking density. The experimental design comprised with four stocking densities such as 40 fish m^{-3}, 60 fish m^{-3}, 80 fish m^{-3}, 100 fish m^{-3} denoted as T_1, T_2,

T_3 and T_4, respectively each of having three replications. Growth, production and survival were determined during the experimental period.

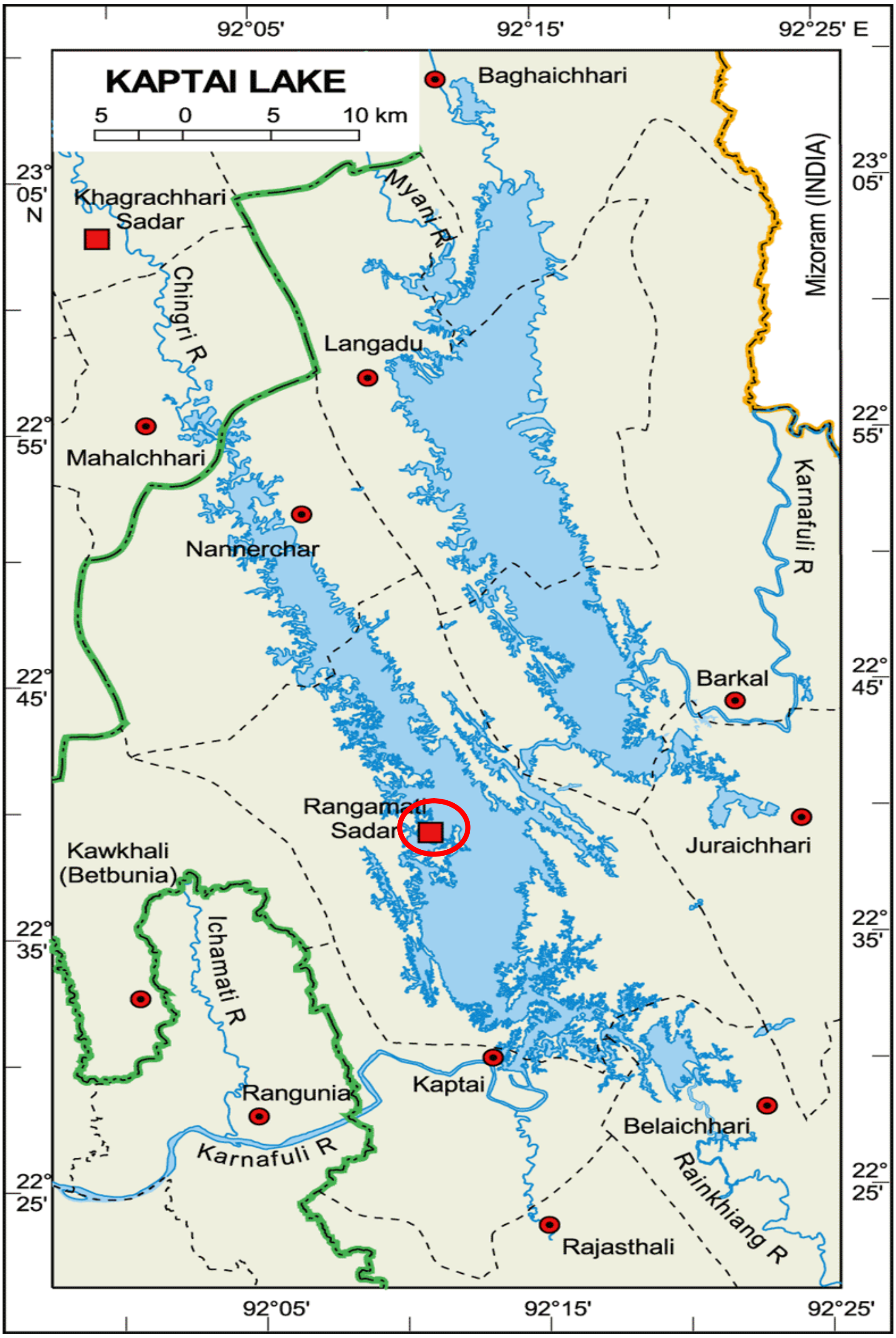

Figure 1. Map of Kaptai Lake with experimental site (shown in red circle).

Figure 2. Experimental cages.

Feeding and proximate analysis of feed. Fish were unfed for the first day in order to acclimatize them to the new environment. From the second day of stocking, feeding was done with pelleted semi-buoyant commercial grower feed at 5-10% of body weight, twice daily at 8:00 hr and 18:00 hr for all treatments. The rate of feeding was 10% of the estimated body weight of fry for the first 15 days, 9% for the second 15 days, 8% for the third 15 days, 7% for the 4^{th} 15 days, 6% for the 5^{th} 15 days, and 5% for the last 15 days. The proximate composition of the grower feed used in the experiment was analyzed following the standard methods given by Association of Official Analytical Chemists (AOAC 1980) at the nutrition laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Proximate composition of the feed is shown in Table 1.

Table 1

Proximate composition of the experimental diet (% dry basis) for Thai climbing perch

Component	*Composition (%)*
Moisture	9.95
Crude protein	28.52
Crude lipid	5.95
Crude fiber	5.60
Crude ash	17.12
NFE[1]	32.86

[1]NFE = Nitrogen free extract [100% − (protein + lipid + ash + fiber + moisture)], a measure of soluble carbohydrates (Castell & Tiews 1980).

Fish sampling and growth parameters study. Fish sampling was carried out in the morning between 7:00 and 9:00 am using a scoop net. Around 10% of fish in each treatment were sampled fortnightly (twice in a month) in order to determine weight (TANITA digital scale, model KD-160, Japan; ± 0.1 g) and total length (measuring scale: ±1.0 mm). At the final harvest, all fish were weighed, measured and the survival rate and mean weight were determined. To determine the growth response of fish, the following parameters were calculated as described by Olvera-Novoa et al (1990) as follows:

Weight gain (WG) = final fish weight (g) – initial fish weight (g);
Feed Conversation Ratio (FCR) = weight of feed given (g)/fish weight gain (g);
Specific Growth Rate (SGR %) = 100 × (ln final wt. - ln initial wt.)/days;
Survival Rate (SR%) = 100 × (number of fish survived/number of fish stocked).

Water quality parameters monitoring. The water quality measurements were made between 7:00 am and 8:00 am on each sampling day. Water quality parameters like air and water temperature (Celsius thermometer), dissolved oxygen (Lutron digital DO, model 5509, Taiwan), and pH (HANNA pocket pH, model HI98107, Italy) were monitored on weekly basis. The free carbon dioxide, total hardness, total alkalinity and ammonia were measured fortnightly following APHA (1992) and using a HACH water analysis kit (Model FF-2, USA).

Management and harvesting. The cages were lifted from water at every 15 days interval to check the net and cleaning purpose. Cages were cleaned with soft brush to remove algae, sponges and other organisms. Dead fish were removed from cages immediately and disposed of in a pit. Loose twine, mesh torn by predators, anchors and sinkers were checked routinely and immediately mended or replaced as needed. Fish were harvested at the end of 90 days culture.

Statistical analysis. The mean values for water quality parameters, growth, survival and production of different treatments were subjected to one-way ANOVA followed by Fisher's least significant difference (LSD) post-hoc test. All statistical analyses were performed using SAS software version 9.1 (SAS Institute Inc., Cary, NC, USA). Standard deviation of each parameter and treatment was determined and expressed as mean±SD. Treatment effects were considered with the significant level at $p < 0.05$.

Results and Discussion

Water quality parameters. Mean values and ranges of water quality parameters over the 90 days culture of Thai climbing perch in Kaptai Lake cages are presented in Table 2.

Table 2

Mean values (mean±SD) and ranges of water quality parameters of experimental cages during the culture period of Thai climbing perch

Parameters	*Values (mean±SD)*
Air temperature (°C)	27±0.89 (22-28)
Water temperature (°C)	26.67±1.03 (23-29)
DO (mg L^{-1})	6.73±0.90 (5.3-7.3)
Free CO_2 (mg L^{-1})	2.50±1.4 (1.8-3.2)
pH	7.42±0.29 (7.0-7.8)
Total hardness (mg L^{-1})	45.45±6.8 (34.2-51.3)
Total alkalinity (mg L^{-1})	48.60±8.3 (38.3-56.5)
Ammonia (NH_3)	Nill

Water quality parameters play a significant role on the maintenance of a healthy aquatic environment and production of fish. In this experiment, during the study period, air and water temperature ranged from 22 to 28°C and 23 to 29°C, respectively. The range of temperature in the experimental cages was within the acceptable ranges for culture of fish and these findings agree with the results found by Rahman & Marimuthu (2010), Haylor & Mollah (1998), Wahab et al (1995), Mollah & Hossain (1998), Rahman et al (2005). Boyd (1982) has also reported that the range of water temperature from 26.06 to 31.97°C is suitable for freshwater fish culture. The concentration of dissolved oxygen in the experimental site ranged from 5.3 to 7.3 mg L^{-1}, which is within the acceptable ranges for fish culture and coincide with the findings of Alamgir (2004), Mollah & Hossain (1998), Rahman & Marimuthu (2010), Rahman et al (2005). The value of free CO_2 ranged from 1.8 to 3.2 mg L^{-1}. pH ranged from 7 to 7.8, the observed pH values were favorable for fish growth and agree well with the findings of Mollah & Hossain (1998), Rahman & Marimuthu (2010), Robert et al (1940). The value of total hardness and total alkalinity ranged from 34.2 to 51.3 mg L^{-1} and 38.3 to 56.5 mg L^{-1}, respectively. Natural water, which contain 40 mg L^{-1} or more total alkalinity, are considered as hard water for biological purposes (Rahman & Marimuthu 2010). Total alkalinity levels in the present study indicate productivity of the lake was medium (Alamgir 2004; Bhuiyan 1970). In this present study, the concentration of total ammonia (NH_3) was nil.

Fish yield parameters. The growth and production performance of fish under four different treatments at the end of the experiment are summarized in Table 3. This table shows the initial length (cm) and weight (g), final length (cm) and weight (g), length gain (cm), weight gain (g), specific growth rate (SGR), feed conversion ratio (FCR) and survival rate of fish. Growth (length and weight) trends of fish at 15 days intervals are shown in Figures 1 and 2. The initial length and weight of fry released in all of the experimental cages were the same. Growth in terms of final length, final weight, length gain, weight gain, SGR and survival rate decreased while FCR increased with increasing fish density in cages. In this study, growth in terms of final length, final weight, length gain, weight gain, specific growth rate and survival of fish were higher in T_1 (40 fish m^{-3}) compared with those of T_2 (60 fish m^{-3}), T_3 (80 fish m^{-3}) and T_4 (100 fish m^{-3}) although the same feed was applied at an equal ratio in all the treatments. The causes might include competition for food and habitat owing to higher number of fish. The results of the present experiment coincide with the findings of Hasan et al (2010), Mollah & Hossain (1998), Rahman & Marimuthu (2010) and Rahman & Monir (2013) during fry/fingerlings rearing of climbing perch in experimental nylon hapas and ponds. However, in this study there was no significant difference between treatments T_1 and T_2 in terms of final weight, weight gain and SGR possibly fish were in stress free condition up to stocking density with 60 fish m^{-3}. In the present study, the average individual fish weight was 31 to 40 g after 90 days culture. Hasan et al (2010) reported that weight gain of Thai climbing perch was ranged from 32.60 g to 37.20 g after 90 days culture in nylon hapas in a pond which agrees with the findings of the present study. However, the result of the present study was much lower than the result of Khatune-Jannat et al (2012), who reported that the average individual harvesting weight of Thai climbing perch was 84 to 90 g after three months culture in ponds. Noor (2005) reported Thai climbing perch obtained length 14.66 cm and weight 57.22 g for 50 days experimental period with supplemental feeding. Mondal et al (2010) and Osofero et al (2009) found that the final weight of individual tilapia (*O. niloticus*) ranged from 78.42 g to 106.81 g and 82.74 g to 111.66 g, respectively after 120 days culture in cages.

In the present study, SGR ranged between 2.24 to 2.52%/day, the highest value 2.52% was observed in T_1 and the lowest 2.24% was observed in treatment T_4. Hasan et al (2010) reported that the SGR value of Thai climbing perch reared in nylon hapas ranged between 3.69 to 3.82%, which was higher than the present study. It might be due to the differences of the source of feed. On the other hand, SGR value 1.11 to 1.43 obtained by Osofero et al (2009) during 91 days culture of tilapia (*O. niloticus*) in cages, this result is very much lower than the present study.

FCR ranged from 2.65 to 2.93, the lowest value 2.65 was observed in T_1 and the highest value 2.93 was observed in T_4. Christensen (1994) reported that FCR of tinfold barb (*Puntius schwanenfeldii*) was 2.8 when fish were fed pellet feed in floating cages which agrees with the results of the present experiment. Hasan et al (2010) found the FCR value of Thai climbing perch reared in nylon hapas ranged from 3.31 to 3.99, which was higher than the present study. It might be due to the use of low quality pellet feed. Osofero et al (2009) reported FCR of 1.56 to 2.21 for tilapia (*O. niloticus*) during 91 days culture in cages. Mondal et al (2010) observed FCR in caged tilapia was 0.79 after 120 days culture. In the present study, FCR of Thai climbing perch culture in cages was very much higher than tilapia culture in cages.

Table 3
Growth performance, feed utilization and survival rate of Thai climbing perch in different treatments after 90 days culture in cages

Parameters	*Stocking densities (fish m^{-3})*			
	T_{40}	T_{60}	T_{80}	T_{100}
Initial length (cm)	5.80±0.26[a]	5.80±0.26[a]	5.80±0.26[a]	5.80±0.26[a]
Final length (cm)	12.50±0.66[a]	11.92±0.55[a]	11.75±0.65[a]	11.15±1.04[a]
Initial weight (g)	4.20±0.62[a]	4.20±0.62[a]	4.20±0.62[a]	4.20±0.62[a]
Final weight (g)	40.42±2.26[a]	39.77±2.04[a]	37.70±1.29[a]	31.37±1.21[b]
Length gain (cm)	6.70±0.17[a]	6.12±0.13[b]	5.87±0.14[b]	5.35±0.21[c]
Weight gain (g)	36.15±0.43[a]	35.47±0.30[a]	33.66±0.60[b]	27.48±0.62[c]
Specific growth rate (%)	2.52±0.03[a]	2.49±0.02[a]	2.44±0.02[b]	2.24±0.03[c]
Feed conversion ratio (FCR)	2.65±0.02[d]	2.73±0.02[c]	2.83±0.03[b]	2.93±0.02[a]
Survival rate (%)	71±1.0[a]	67±1.0[b]	65.15±1.19[b]	57.67±1.53[c]

Values are means from triplicate groups of fish where the values in each row with different superscripts are significantly different ($p < 0.05$).

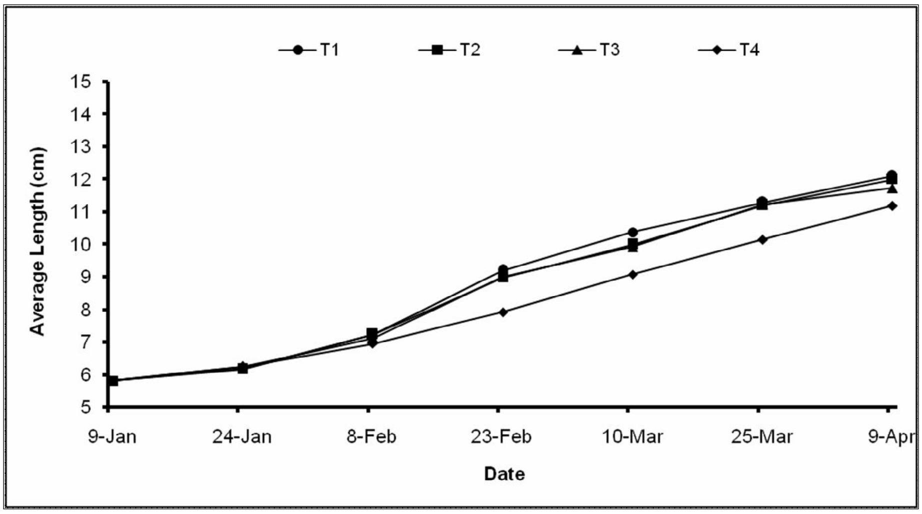

Figure 1. Changes in the average individual length of juvenile Thai climbing perch at different stocking densities over the culture period of 90 days.

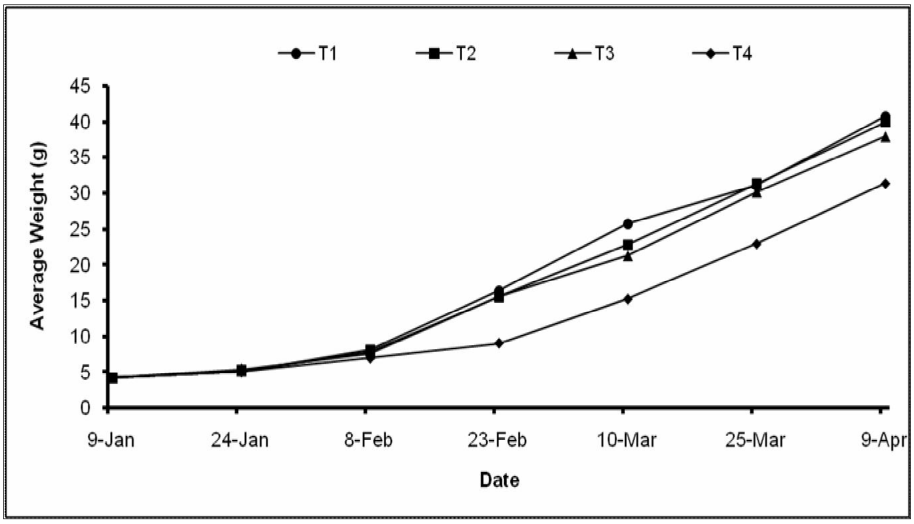

Figure 2. Changes in the average individual weight of juvenile Thai climbing perch at different stocking densities over the culture period of 90days.

Survival rate of fish during the experimental period was ranged from 57.67 to 71%, the lowest value 57.67% was observed in T_4 and the highest value 71% was observed in T_1 (Table 3). Hasan et al (2010) reported that survival rate of same fish species in nylon hapas ranged from 73% to 83%, which was higher than the present study. Noor (2005) found that survival rate of the species was 81.67% for 50 days experimental period in ponds with a handmade feed. Osofero et al (2009) found that the survival rate of 98 to 99.5%, for tilapia (*O. niloticus*) during 91 days culture in cages which is higher than the present study.

Conclusions. The present study shows that the growth, survival and production of Thai climbing perch were inversely related to the stocking densities of fish. In all respects, a stocking density of (60 fish m^{-3}) could be recommended for the successful cage aquaculture of this important exotic species in lake environment. However, more research is still needed to increase the production, survival rate and optimization of stocking density in cages.

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