TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC QUY NHƠN

Ảnh hưởng của độ mặn đến sinh trưởng và sống sót của cá rô đầu vuông (*Anabas testudineus*) ở giai đoạn cá hương đến cá giống

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TÓM TẮT

Thí nghiệm này được thực hiện nhằm đánh giá khả năng thích nghi độ mặn của cá rô đầu vuông. Cá có khối lượng trung bình 1,5g được lựa chọn để bố trí nuôi ở các độ mặn 0, 5, 10 và 15‰. Cá được nuôi trong các bể 1m^3 với mật độ 200 con/bể. Các chỉ tiêu về sinh trưởng và tỷ lệ sống của cá được khảo sát định kỳ 10 ngày một lần. Kết quả cho thấy, ở độ mặn 5‰ cá sinh trưởng tốt, tương đương với môi trường nước ngọt (0‰). Ngược lại, khi độ mặn tăng lên 10‰ và 15‰ thì sinh trưởng của cá có xu hướng giảm dần. Tỷ lệ sống của cá đạt từ 86,67 - 95,67%, trong đó cá sống sót tốt nhất ở 0‰ và 5‰. Từ những kết quả này có thể nhận định rằng, mặc dù có sự khác nhau về sinh trưởng và sống sót của cá rô đầu vuông giữa các độ mặn thí nghiệm nhưng nhìn chung cá có thể thích nghi tốt ở khoảng độ mặn 0 -15‰, đặc biệt là ở độ mặn thấp (≤ 5‰).

Từ khóa: *Anabas testudineus, cá rô đầu vuông, độ mặn, sự thích nghi.*

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Effects of salinity on growth and survival of square head climbing perch (*Anabas testudineus*) in the early juvenile to juvenile stage

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ABSTRACT

This study was conducted to assess salinity adaptation of square head climbing perch. Fish with average body weight of 1.5g were selected to rear at the salinities of 0‰, 5‰, 10‰ and 15‰. Fish were cultured in tanks (1m^3) with the density of 200 individuals/tank. The growth and survival of fish were examined every ten days. The results showed that fish well grew at both salinity of 0‰ and 5‰ while its growth gradually decreased with increasing the salinity from 10‰ to 15‰. Survival rate of fish was from 86,67% to 95,67% and its highest values were obtained at the salinity of 0‰ and 5‰. Based on the results of this study, it is believed that despite different growth and survival of fish between the experimental salinities, in general square head climbing perch can well adapt to the salinity range of 0 - 15‰, especially at low salinity (≤ 5‰).

Keywords: *Anabas testudineus, square head climbing perch, salinity, adaptation.*

1. INTRODUCTION

Agricultural production plays an important role in the economic development of Binh Dinh as well as South Central Coastal provinces. However, recently, because of impacts of climate change, lots of agricultural lands in Tuy Phuoc, Phu Cat, Phu My and Hoai Nhon districts have become alum and saline lands that are not effective for production or cannot be used for rice production. To deal with this situation, farmers in above districts have tended to used these lands for aquaculture. Therefore, it is essential to find aquatic species adaptable for environmental conditions in these areas.

Square head climbing perch (*Anabas testudineus* Bloch, 1792) is a variable fish species from climbing perch. This species can grow twice to three times faster than climbing perch and can adapt well to different environmental conditions. Moreover, the production of square head climbing perch can bring high economic benefit. Ngo Huu Toan and Nguyen Van Khanh[1,2] indicated that square head climbing perch can well adapt to different salinities, so it can be selected to culture in brackish waters. However, these authors only conducted the study on this fish species in juvenile stage, therefore its salinity adaption in early juvenile stage has not been

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known yet. Examining the salinity adaption of square head climbing perch in such early stages is very important for the following reasons: (1) can help promote survival and growth of fish when it is cultured in brackish waters later; (2) the bases that help culturists directly rear early juvenile stage to juvenile stage of this fish in brackish ponds to support the grow-out culture in the same condition to reduce the input cost compared to buying juveniles. The study "Effects of salinity on growth and survival of square head climbing perch (*Anabas testudineus*) in the early juvenile stage" was carried out for these above reasons.

2. SUBJECT AND METHODS

2.1. Subject

The early juveniles of square head climbing perch (*Anabas testudineus*) were bought from My Chau experimental farming for aquaculture, Phu My - Binh Dinh.

2.2. Methods

2.2.1. Experimental design

The strong early juvenile fish with average body weight of 1.5g and total length of 22mm were selected for the experiment. Fish were cultured in the composite tanks ($1m^3$) within 30 days with density of 200 individuals/tank and divided into 4 saline treatments as NT1 (0‰ - control), NT2 (5‰), NT3 (10‰), NT4 (15‰) with 3 replicates. We chose salinity range of 0 - 15‰ to do the experiment because this is usually used to examine salinity adaption of freshwater fish.[1,2,3,4,5] The freshwater from the underground well and marine water from the sea at My Duc community were used to mix to the experimental salinity levels using method Pearson square.

Fish were fed by floating pelleted feed (SKRETTING) with size of 0.5 - 1mm and 42% protein. Fish were fed 6 - 10% body weight twice a day at 7 - 8 am and 4 - 5 pm. Water was exchanged 25% every 10 days during the experiment. The tank bottom was daily cleared by manually siphoning out and corresponding amount of water was supplemented.

2.2.2. Water parameters examination

Temperature was daily examined using the thermometer with the accuracy of 1^0C.

pH was daily examined using the electronic equipment HANNA with the accuracy of 0.01.

DO was daily examined using the electronic equipment HANNA with the accuracy of 0.01.

Salinity was examined using the salinity refractometer with the accuracy of 1‰.

2.2.3. Fish growth and survival examination

- Growth of fish: Body weight and total length of fish were measured every 10 days to examine growth of fish.

- Absolute growth rate for body weight and total length of fish were determined by the formula:

$$A = \frac{W_1 - W_0}{t_1 - t_0}$$

In which:

A: Absolute growth rate for body weight (g/day) and total length (mm/day) of fish.

W_0: Body weight (g) or total length (mm) at time t_1

W_1: Body weight (g) or total length (mm) at time t_2

$t_1 - t_0$: Time period between two examinations (day).

- Survival of fish were examined every 10 days using the formula:

$$\mathbf{S\% = \frac{S2}{S1} \times 100}$$

In which:

S1: Number of fish at the beginning

S2: Number of fish at the end

2.3. Data analysis

Microsoft Excel 2010 was used to calculate the average value and standard deviation. We used one way ANOVA to examine the difference of studied parameters between experimental treatments using SPSS 20.0.

3. RESULTS AND DISCUSSION

3.1. Water parameters

Water parameters such as temperature, pH, DO are the basic ones to assess the water quality in aquaculture. When these parameter are suitable for aquatic animals in general and fish in particular, they well grow and develop and thus the results of study are accurate. The water parameters in the experimental tanks were showed in Table 1.

Table 1. The water parameters in the experimental tanks

Treatments	Temperature (^{0}C)			pH			DO (mg/l)		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
NT1	24.0	31.0	27.42	6.5	6.9	6.81	4.5	6.0	5.22
NT2	24.0	31.0	27.37	6.8	7.2	7.09	4.5	6.0	5.28
NT3	24.0	31.0	27.38	7.0	7.4	7.12	4.5	6.0	5.25
NT4	24.0	31.0	27.38	7.3	7.7	7.13	4.5	6.0	5.20

Remarks: Min: minimum value; Max: maximum value; Average: average value

The experiment was conducted in a house, so water temperature between the treatments were relatively stable, that was lowest at 24^{0}C, highest at 31^{0}C and average at 27.37 – 27.42^{0}C. This temperature range is suitable for growth and development of tropical aquatic organisms.[5]

pH of water fluctuated from 6.5 to 7.7 and increased with salinity raising in the treatments. Specifically, average value of pH was lowest (6.81) in NT1 (salinity of 0‰) and highest (7.13) in NT4 (salinity of 15‰). Such variation is due to pH of freshwater lower than that of marine water, therefore the higher salinity of the mixture of two kinds of water is, the higher pH can obtain. According to Nguyen Thanh Phuong et al.,[6] climbing perch can inhabit in waters with pH from 5 to 10, but optimal pH for it is from 6 to 9. Square head climbing perch has similar behaviors to climbing perch, so it will also adapt well to this pH range. Thus, pH of water in the experimental tanks is suitable for growth and development of square head climbing perch.

Concentration of DO was from 4.5 - 6 mg/l, that is suitable for fish,[8] and this was not greatly different between treatments.

In summary, enviromental parameters in experimental tanks are suitable for square head climbing perch, so experimental results are not affected.

3.2. Effects of salinity on growth of fish

3.2.1. Effects of salinity on cumulative weight growth of fish

Cumulative weight growth of fish in four treatments as NT1, NT2, NT3 and NT4 is expressed in Table 2.

Table 2. Cumulative weight growth (g) of square head climbing perch

Treatment	Progressed time of rearing			
	Day 0	Day 10	Day 20	Day 30
NT1	1.50 ± 0.12^{a}	1.88 ± 0.10^{a}	2.41 ± 0.13^{a}	3.03 ± 0.14^{a}
NT2	1.50 ± 0.12^{a}	1.87 ± 0.10^{a}	2.42 ± 0.11^{a}	3.02 ± 0.13^{a}
NT3	1.50 ± 0.12^{a}	1.85 ± 0.11^{b}	2.29 ± 0.11^{b}	2.77 ± 0.13^{b}
NT4	1.50 ± 0.12^{a}	1.83 ± 0.11^{c}	2.25 ± 0.13^{c}	2.71 ± 0.12^{c}

Remark: in the same column, the different letters indicate significant difference ($p < 0.05$).

The results showed that weight of fish increased according to rearing time. Particularly, fish weighing 1.5g at the beginning of experiment grew to 2.71 – 3.03g after 30 days of rearing.

Weight of fish between NT1 and NT2 was not significant different ($p > 0.05$) at day 10, day 20 and day 30 but higher than that in NT3 và NT4 ($p < 0.05$). Weight of fish in NT4 was lowest ($p < 0.05$). Particularly, at the end of the experiment (day 30) weight of fish in NT1 and NT2 were 3.03g and 3.02g respectively while this in NT3 and NT4 were 2.77g and 2.71g. Therefore, it can be said that cumulative weight growth of early juveniles of square head climbing perch reared at salinity of 5‰ is similar to that of fish raised in freshwater. However, if fish are reared at higher salinity levels as 10‰ and 15‰, its cumulative weight growth tends to decrease.

The similar results are also reported in some studies. Nguyen Van Kiem and Trang Van Phuoc[4] reared snakeskin gourami (*Trichogaster pestoralis*) at salinity range of 0 - 13‰ and showed that there was no difference of body weight of fish at the end of the experiment between the experimental salinity levels as 0‰, 5‰ and 7‰ but weight of fish gradually decrease with increasing salinity. Similarly, weight of climbing perch with initial weight of 7 - 8g reared at salinities of 0 - 15‰ was highest at 0‰ và 3‰ and lowest at 12‰ and 15‰ after 90 days.[3] Thus, it can be seen that square head climbing perch as well as snakeskin gourami and climbing perch can only grow well in low saline waters.

3.2.2. Effects of salinity on cumulative length growth of fish

Cumulative length growth of fish in four treatments is expressed in Table 3.

Table 3. Cumulative length growth (mm) of square head climbing perch

Treatment	Progressed time of rearing			
	Day 0	Day 10	Day 20	Day 30
NT1	22.00 ± 0.04^{a}	30.33 ± 1.62^{a}	39.33 ± 1.76^{a}	48.92 ± 1.94^{a}
NT2	22.00 ± 0.04^{a}	30.32 ± 1.68^{a}	39.26 ± 1.62^{a}	48.80 ± 2.07^{a}
NT3	22.00 ± 0.04^{a}	29.18 ± 1.82^{b}	36.98 ± 2.03^{b}	45.11 ± 2.13^{b}
NT4	22.00 ± 0.04^{a}	29.09 ± 1.73^{b}	36.64 ± 1.86^{b}	44.62 ± 2.26^{b}

Remark: in the same column, the different letters indicate significant difference ($p < 0.05$).

Similar to cumulative weight growth, length of fish also increased according to rearing time. Particularly, initial length of fish was 22mm and after 30 days of rearing, total length of fish increased to 48.92mm in NT1, 48.8mm in NT2, 45.11mm in NT3 and 44.62mm in NT4.

Total length of fish in NT1 and NT2 was always higher than that in NT3 and NT4 at day 10, day 20 and day 30 ($p < 0.05$). However, there was no significant difference of total length of fish between NT1 and NT2 as well as NT3 and NT4 ($p > 0.05$). Particularly, at the end of the experiment, total length of fish in NT1 was 30.33mm similar to that in NT2 (30.32mm) while total length of fish in NT3 was 29.18mm similar to that in NT4 (29.09mm). Therefore, it can be said that cumulative length growth of early juveniles of square head climbing perch reared at salinity of 5‰ is similar to that of fish raised in freshwater. However, if fish are reared at higher salinities as 10‰ and 15‰, its cumulative length growth tends to decrease. Our results are not similar to the findings of Le Thi Phuong Mai et al.[5] on snakeskin gourami (*Trichogaster pestoralis*), that showed that length of fish was highest after 90 days of rearing at salinity of 9‰ compared to 0‰, 3‰ and 6‰. However, in the experiment of these authors, survival of fish reared at 9‰ was lowest so fish can grow fast because of low density.

3.2.3. Effects of salinity on absolute growth rate for body weight of fish

Based on cumulative weight growth of fish, we calculated its absolute growth rate for body weight in the experimental treatments and the results are showed in Table 4.

Table 4. Absolute growth rate for body weight of fish (g/day)

Treatment	Time period of rearing			
	Day 0 - day 10	**Day 10 - day 20**	**Day 20 - day 30**	**Day 0 - day 30**
NT1	0.038 ± 0.001^{a}	0.053 ± 0.001^{a}	0.061 ± 0.009^{a}	0.051 ± 0.004^{a}
NT2	0.037 ± 0.001^{a}	0.055 ± 0.001^{a}	0.060 ± 0.009^{a}	0.051 ± 0.004^{a}
NT3	0.035 ± 0.001^{b}	0.044 ± 0.001^{b}	0.048 ± 0.009^{b}	0.042 ± 0.004^{b}
NT4	0.034 ± 0.001^{b}	0.041 ± 0.001^{c}	0.046 ± 0.009^{c}	0.040 ± 0.004^{c}

Remark: in the same column, the different letters indicate significant difference ($p < 0.05$).

In general, absolute growth rate for body weight of fish gradually increased according to time periods of rearing (Table 4). This give a speculation that fish can well grow in next rearing periods.

Absolute growth rate for body weight of fish was different between treatments. In the period of day 0 to day 10 of rearing, this in NT1 and NT2 was significantly higher than that in NT3 and NT4 ($p < 0.05$) but there was no difference of this between NT1 and NT2 as well as between NT3 and NT4 ($p > 0.05$). In the period of day 10 to day 20 and day 20 to day 30 of rearing, absolute growth rate for body weight of fish in NT1 and NT2 was not significantly different ($p > 0.05$) and was highest, however this in NT3 and NT4 was different and the lowest value was seen in NT4 ($p < 0.05$).

For pooled results of 30 days of rearing, treatment NT1 (salinity of 0‰) and NT2 (salinity of 5‰) still showed the superior absolute growth rate for body weight compared to NT3 (salinity of 10‰) and NT4 (salinity of 15‰) ($p < 0.05$), of which growth rate of fish in NT4 was lowest. Therefore, like cumulative weight growth, absolute growth rate for body weight of early juvenlies of square head climbing perch reared at salinity of 5‰ is similar to that of fish raised in freshwater. However, if fish are reared at higher salinity levels as 10‰ and 15‰,

its growth tends to be lower. Unlike, Ngo Huu Toan and Nguyen Van Khanh[2] reported that absolute growth rate for body weight of square head climbing perch in grow-out culture at the salinity levels of 0, 4‰, 8‰ and 12‰ was not different. The different results between this study and our study may be due to different ontogenetic stages of experimental fish; we conducted the experiment on early juveniles (1.5g in initial body weight) while these author did on juvenlies (2.28g in initial body weight). Therefore, it can be speculated that salinity adaptation of different ontogenetic stages of square head climbing perch is different.

3.2.4. Effects of salinity on absolute growth rate for total length of fish

Based on cumulative length growth of fish, we calculated its absolute growth rate for total length in the experimental treatments and the results are showed in Table 5.

Bảng 5. Absolute growth rate for total length of fish (mm/day)

Treatment	Time period of rearing			
	Day 0 - day 10	Day 10 - day 20	Day 20 - day 30	Day 0 - day 30
NT1	0.83 ± 0.16^{a}	0.90 ± 0.23^{a}	0.96 ± 0.16^{a}	0.90 ± 0.06^{a}
NT2	0.83 ± 0.17^{a}	0.89 ± 0.21^{a}	0.95 ± 0.19^{a}	0.89 ± 0.07^{a}
NT3	0.72 ± 0.18^{b}	0.78 ± 0.14^{b}	0.81 ± 0.19^{b}	0.77 ± 0.07^{b}
NT4	0.71 ± 0.17^{b}	0.76 ± 0.14^{b}	0.80 ± 0.17^{b}	0.75 ± 0.08^{b}

Remark: in the same column, the different letters indicate significant difference ($p < 0.05$).

In general, absolute growth rate for total length of fish gradually increased according to time periods of rearing (Table 5). This give a speculation that length growth of fish can rapidly increase in next rearing periods.

Absolute growth rate for total length of fish was different between treatments. In all periods of rearing, this in NT1 and NT2 was significantly higher than that in NT3 and NT4 ($p < 0.05$) but there was no difference of this between NT1 and NT2 as well as between NT3 and NT4 ($p > 0.05$).

For pooled results of 30 days of rearing, treatment NT1 (salinity of 0‰) and NT2 (salinity of 5‰) still showed the superior absolute growth rate for total length compared to NT3 (salinity of 10‰) and NT4 (salinity of 15‰) ($p < 0.05$). Therefore, it can be said that absolute growth rate for total length of early juvenlies of square head climbing perch reared at salinity of 5‰ is similar to that of fish raised in freshwater. However, if fish are reared at higher salinity levels as 10‰ and 15‰, its absolute growth rate for total length is lower.

The similar results are also found in grow-out culture of this fish; absolute growth rate for total length is highest at salinity of 0‰ and 4‰, followed by salinity of 8‰ and 12‰ and lowest at 16‰[2]. Thus, it can be seen that absolute growth rate for total length of square head climbing perch gradually reduces when fish are cultured in salinity more than 5‰.

3.3. Effects of salinity on survival of fish

Survival of fish in the treatments is showed in Table 6.

Table 6. Survival (%) of square head climbing perch in the stage of early juvenile to juvenlie

Treatment	Time period of rearing			
	Day 0 - day 10	Day 10 - day 20	Day 20 - day 30	Day 0 - day 30
NT1	98.30[a]	98.47[a]	98.80[a]	95.67[a]
NT2	98.00[a]	98.64[a]	98.97[a]	95.67[a]
NT3	93.33[b]	96.25[b]	98.51[a]	88.00[b]
NT4	92.50[b]	96.03[b]	97.98[a]	86.67[b]

Remark: in the same column, the different letters indicate significant difference ($p < 0.05$).

In general, survival of fish in the experimental treatments was high (> 86%), which indicates that fish well adapted to the culture environment. Survival of fish in this study is much higher than that of snakeskin gourami reared at salinities of 0 - 13‰ (2.45 - 82.31%)[4].

Survival of fish tended to increase according to rearing periods (Table 6), which implies that fish gradually adapt to the culture environment in the experimental tanks. However, there was the difference of survival of fish between treatments. In two first periods of rearing (day 0 - day 10 and day 10 - day 20), survival of fish in NT1 and NT2 was higher than that in NT3 and NT4 ($p < 0.05$). This indicates that fish reared in high salinities (10‰ and 15‰) died more than those cultured in freshwater and 5‰. It is speculated that fish did not immediately adapt to high salinity because of the osmotic pressure difference between the body and the environment. In contrast, in the period of day 20 - day 30 of rearing, survival of fish between treatments did not differ ($p > 0.05$), implying that fish well adapted to the enviromental conditions in the experimental tanks.

The accumulative results of 30 days of rearing showed that survival of fish in NT1 - 0‰ and NT2 - 5‰ (95.67%) was higher than that in NT3 - 10‰ (88%) and NT4 - 15‰ (86.67%) ($p < 0.05$). There was no difference of survival of fish between NT1 and NT2 as well as NT3 and NT4 ($p > 0.05$). The similar results are also reported by Do Thi Thanh Huong et al. (2013)[3] on climbing perch with initial body weight of 7 - 8g; after 90 days of rearing, survival of fish was highest at 0‰ (97.5%) and 3‰ (96.7%) and gradually decreased at 9‰, 12‰ and 15‰. Nguyen Van Kiem và Trang Van Phuoc[4] also showed that survival of snakeskin gourami was highest at salinities of 0‰ and 3‰ (80.45 - 82.31%) and gradually decreased at salinities of 5‰, 7‰, 9‰, 11‰ and 13‰. Therefore, square head climbing perch, climbing perch or snakeskin gourami can survive well at low saline waters and when water salinity increases the rate for fish survival reduces.

4. CONCLUSION

Our results show that square head climbing can adapt well to the salinity up to 15‰ in the stage of early juvenile to juvenile. However, uniquely, growth and survival of fish reared at salinity of 5‰ are similar to that at freshwater while these of fish gradually decrease at the higher salinity levels. Therefore, it can be concluded that juveniles of fish in the mentioned stage can be cultured at waters with salinity ≤ 15‰ but it is better to rear it at salinity ≤ 5‰.

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