Ảnh hưởng của độ sâu mực nước đến sinh trưởng và tỷ lệ sống của ốc bươu đồng (*Pila polita*) trong điều kiện ương

TÓM TẮT

Ốc bươu đồng (*Pila polita*) là một loài có chất lượng thịt ngon và giàu dinh dưỡng, vì vậy chúng đang là đối tượng đầy triển vọng cho nuôi trồng thủy sản. Nghiên cứu này được thực hiện để đánh giá ảnh hưởng của các độ sâu mực nước đến sinh trưởng và tỷ lệ sống của ốc bươu đồng. Ốc được ương thử nghiệm tại 4 độ sâu khác nhau là 15 cm, 20 cm, 25 cm và 30 cm với mật độ 300 con/bể 50cm x 40cm và được lặp lại 3 lần. Ốc được cho ăn bèo cám trong 15 ngày đầu và bầu, bí trong 15 ngày tiếp theo. Kết quả thí nghiệm cho thấy, sau 30 ngày ương, ốc được ương tại 30 cm cho giá trị sinh trưởng chiều cao và cân nặng lớn nhất (lần lượt là 12,87 mm và 0,495g) trong khi chiều rộng đạt giá trị cao nhất tại độ sâu 25 cm và 30 cm (lần lượt là 9,62 mm và 9,59 mm). Tỷ lệ sống của ốc dao động từ 97,17 – 97,83%, trong đó ốc được ương tại 15 cm có tỷ lệ sống thấp hơn 3 nghiệm thức còn lại. Như vậy, xét tổng thể có thể thấy độ sâu mực nước 30 cm là phù hợp nhất đối với việc ương ốc.

Từ khóa: *Ốc bưu đồng, sinh trưởng, tỷ lệ sống, độ sâu mực nước*

Effects of water depths on growth and survival of black apple snail (*Pila polita*) in rearing condition

ABSTRACT

The black apple snails (*Pila polita*) is a species with delicious meat and rich nutrition, so it is a promising target for aquaculture. This study was conducted to evaluate the effects of water depths on growth and survival rate of this species. The snails were experimentally reared at 4 different water depths of 15 cm, 20 cm, 25 cm and 30 cm with stocking density of 300 individuals per tank 50 cm x 40 cm and repeated 3 times. The snails were fed duckweed in the first 15 days and fresh calabash in the next 15 days. The experimental results showed that after 30 days of rearing, the snails reared at 30 cm had the highest height and weight (12.87 mm and 0.495 g, respectively) while the width of snails reached the highest values at depths of 25 cm and 30 cm (9.62 mm and 9.59 mm, respectively). The survival rate of snails ranged from 97.17 - 97.83%, in which snails reared at 15 cm had the lower survival rate than other 3 treatments. Thus, in general, it can be seen that the water depth of 30 cm is the most suitable for rearing snails.

Keywords: *Black apple snail, growth, survival, water depths*

1. INTRODUCTION

Black apple snail (*Pila polita*) is a relatively new species, belonging to the Gastropod phylum, with delicious meat and rich nutrients therefore it is a quite promising species for aquaculture. Culturing black apple snails has taken place widely in freshwater bodies across the country, especially in the Mekong Delta because snails have great potential for farming, high consumption demand and bring stable economic efficiency to farmers. However, the natural resources of black apple snails are decreasing due to the invasion of the golden apple snail, overexploitation and increasingly polluted environment[1]. There have been some studies on seed production and rearing[2], or biological characteristics of black apple snails[2-4]. Some other studies mentioned effects of densities on growth and survival[5], effects of different protein levels in diet on growth and survival[6], or effects of pellet food supplemented Yucca Formulation on growth and survival rate of this species[7]. In addition, effects of some environmental factors on black apple snails have been reported in some researches, for example, effects of light conditions on the hatching rate, growth and survival rate[1], effects of pH on growth and survival[8]. However, in the world and also in Vietnam, there have not been any studies on the effects of water depths on growth or survival of this species. Therefore, this is the first to exmaine effects of water depths on black apple snails during the rearing period.

2. MATERIALS AND METHODS

2.1. Experimental design

After hatched 1 day, snails were chosen to arrange the experiment of water depth levels. The experiment was repeated 3 times with 4 different water levels (15 cm, 20 cm, 25 cm and 30 cm) used to rear snails in the tank of 50 cm x 40 cm. Water lettuces were used as the substrate with a distribution area of ¼ of the tanks. 300 snails were selected and arranged in each tank. Total of rearing time was 30 days. In the first 15 days, the snails were fed duckweed and in the next 15 days, they were fed fresh calabash twice a day (morning and afternoon). Every 3-4 days, 50% of water in the tank

was siphoned and changed, and 100% of the water was changed every 10 days.

2.2. Measurement of factors

The environment factors were defined. Temperature was measured every day using thermometer AS ONE JC-2211, and pH and DO were measured every day while NH_3 was measured every 5 days using test Sera – Germany.

Survival and growth (the height, width and weight) of snails were examined every 10 days. Survival of snails was calculated as percentage of number of snails at examining time per number of snails at beginning. The height and width of snails were measured using a caliper with the accuracy of 0.1 mm according to the method of Olena et al.[9]. The weight of snails was measured using a scale with accuracy 0.01g.

2.3. Data analysis

Mean values, standard deviation were analysed using Microsoft Excel 2013. SPSS 20.0 using One-way ANOVA with LSD post hot test was applied to compare the differences between means of the treatments with significance $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. The environmental factors

During the experiment, temperature varied from 27-29^{0}C. Suitable temperature for black apple snails is 20-32^{0}C. When the temperature is below 15^{0}C or above 40^{0}C, the snails go into hibernation or aestivation[10]. Aquatic animals grow well at temperatures of 25-30°C[11], or proper temperature for carp culture is between 24 and 30°C[12]. Thus, the temperature in the experiment is suitable for black apple snails.

Water was changed every 3-4 days, so pH was stable with a value of 6.5. Thao and Binh[7] reared these snails with 3 levels of pH (6, 7 and 8) and reported that snails grew and survived best at pH of 8. Phu and Ut[13] believed that suitable pH for aquatic animals is from 6.5 -9.0. Santhosh and Singh reported that the suitable pH range for fish culture is 6.7 - 9.5[12]. According to Wurts and Durborow[14], Bhatnagar et al.[15], a pH between 6.5 and 9 is essential for aquaculture pond. Therefore, the pH value in this experiment is in a proper range although it is not the most optimal for black apple snails.

In this study, DO was 5mg/L and NH_3 was less than 0.03mg/L. Bhatnagar et al.[15] and Bhatnagar and Singh[16] reported that DO >5 ppm is essential for good aquaculture while Ekubo and Abowei[17] believed that if fish are exposed to less than 0.3 mg/L of DO for a long time period, they can die and 5.0 mg/L is adequate for them. The toxic levels of NH_3 for short-term exposure usually lie between 0.6 and 2.0 mg/L, and sublethal effects may occur at 0.1 to 0.3 mg/L[18]. Maximum limit of ammonia concentration for aquatic animals is 0.1 mg/L[12]. According to Vietnamese standard TCVN13952:2024 for freshwater aquaculture, proper DO and NH_3 for freshwater animals are more than 4mg/L and less than 0.1 mg/L respectively[19]. Thus, these values in the experiment are suitable for black apple snails.

3.2. The growth of black apple snails

At 10 days of rearing, the height of snails reared at 30 cm was highest, with value of 7.23 mm ($p<0,05$) while these values in 3 remaining treatments were not different ($p>0,05$). After 20 days of rearing, snails cultured at 15 cm had the lowest height (8.22 mm), followed by snails reared at 20 cm (8.87 mm), at 25 cm and 30 cm (9.97 mm and 9.90 mm respectively, $p<0,05$). However, the height of snails reared at 25 cm and 30 cm did not differed at 20 days of rearing ($p>0.05$). At 30 days (Table 1), the height of snails in 4 treatments was totally different, of which, snails reared at 30 cm had the highest value (12.87 mm), followed by the values at 25 cm, 20 cm and 15 cm (12.06 mm, 11.08 mm and 10.54 mm respectively) ($p<0.05$). Thus, the deeper water levels may be more suitable for the height growth of snails.

Table 1. The height (mm) of black apple snails at different water levels

Rearing time (days)	Water depths			
	15 cm	20 cm	25 cm	30 cm

0	3.62 ± 0.14[a]	3.62 ± 0.14[a]	3.62 ± 0.14[a]	3.62 ± 0.14[a]
10	6.72 ± 0.47[b]	6.58 ± 0.42[b]	6.56 ± 0.45[b]	7.23 ± 0.58[a]
20	8.22 ± 0.48[c]	8.87 ± 0.85[b]	9.97 ± 0.96[a]	9.90 ± 0.67[a]
30	10.54 ± 0.41[d]	11.08 ± 0.57[c]	12.06 ± 0.44[b]	12.87 ± 0.84[a]

Note: In the same row, the different superscritp letters indicate the significant difference (p<0.05). n=30

Similar to the height, after 10 days of rearing, the width of snails reared at water depth of 30 cm reached the highest value (5.83 mm, p<0.05) while the width of snails cultured at the 3 remaining water depths (15 cm, 20 cm and 25 cm) was not significant different (p>0.05). After 20 and 30 days of rearing, the widths of snails at water levels of 15 cm and 20 cm were not significant different (p>0.05) and smaller than those at water depths of 25 cm and 30 cm (p<0.05). At 30 days of rearing (Table 2), the snail width at 15 cm, 20 cm, 25 cm and 30 cm were 8.30 mm, 8.51 mm, 9.62 mm and 9.59 mm respectively. Therefore, it can be seen that snails adapt better at deeper water levels when they grow up.

Table 2. The width (mm) of black apple snails at different water levels

Rearing time (days)	Water depths			
	15 cm	**20 cm**	**25 cm**	**30 cm**
0	3.06 ± 0.05[a]	3.06 ± 0.05[a]	3.06 ± 0.05[a]	3.06 ± 0.05[a]
10	5.28 ± 0.34[b]	5.25 ± 0.26[b]	5.34 ± 0.41[b]	5.83 ± 0.42[a]
20	6.68 ± 0.43[b]	6.75 ± 0.67[b]	7.75 ± 0.31[a]	7.63 ± 0.56[a]
30	8.30 ± 0.26[b]	8.51 ± 0.49[b]	9.62 ± 0.43[a]	9.59 ± 0.65[a]

Note: In the same row, the different superscritp letters indicate the significant difference (p<0.05). n=30

The weight of snails after 10 days of rearing was highest at the depth of 30 cm (p>0.05) while in the remaining 3 treatments was not statistical difference (p>0.05). After 20 days of rearing, the weight of snails at 25 cm and 30 cm were the highest (0.224 g and 0.226 g, respectively, p<0.05), followed by weight at the depth of 20 cm (0.200 g) while this at the depth of 15cm was still the smallest (0.157 g, p<0.05). After 30 days of rearing, the weight of snails in the 4 treatments was completely different (Table 3). Specifically, the weight of snails at the depth of 15 cm was the smallest (0.290 g), followed by this at 20 cm (0.328 g), 25cm (0.454 g) and the highest value was at the depth of 30 cm (0.495 g). In general, snails tend to grow better when reared at greater depths.

Table 3. The weight (gram) of black apple snails at different water levels

Rearing time (days)	Water depths			
	15 cm	**20 cm**	**25 cm**	**30 cm**
0	0.015 ± 0.005[a]	0.015 ± 0.005[a]	0.015 ± 0.005[a]	0.015 ± 0.005[a]
10	0.084 ± 0.019[b]	0.083 ± 0.017[b]	0.080 ± 0.018[b]	0.103 ± 0.023[a]

20	0.157 ± 0.019^{c}	0.200 ± 0.053^{b}	0.224 ± 0.027^{a}	0.226 ± 0.040^{a}
30	0.290 ± 0.033^{d}	0.328 ± 0.040^{c}	0.454 ± 0.067^{b}	0.495 ± 0.095^{a}

Note: In the same row, the different superscritp letters indicate the significant difference (p<0.05). n=30

After 30 days of rearing, with initial height, width and weight of 3.62 mm, 3.06 mm and 0.015 g respectively, the black apple snails reached the height of 10.54 - 12.87 mm, the width of 8.30 - 9.62 mm and the weight of 0.290 - 0.495 g. These results are much higher than those of report by Binh and Thao[5] although these authors reared snails at the lower density and longer time than us. Specifically, Binh and Thao[5] reported that after 35 days of rearing, the height and weight of the snails only reached from 7.77 mm and 0.12 g at the density of 1200 snails/m^2 to 9.81 mm and 0.22 g at the density of 300 snails/m^2. In another study of Thao and Binh[8], snails reared at the density of 50 individuals/tank of 80 x 40 cm at different pH values also gave the lower growth at pH of 6 and 7 after 40 days of rearing compared to our results at pH of 6.5 after 30 days of rearing (heights ranging from 7.05 - 11.97 mm and weights ranging from 0.13 – 0.61 g). Or, Thao et al.[7] used pellet food supplemented Yucca formulation to feed black apple snails and the weight and height of snails after 40 days of rearing were only 0.45 – 0.50 g and 12.41 – 12.92 mm respectively. We reared snails in the tanks of 50 x 40 cm at the density of 300 snails/tank (equivalent to 1500 snails/m^2) and used duckweed and fresh calabash as food while the above authors fed them with industrial food. This may suggest that, at the early stage, industrial food may not be completely suitable for black apple snails. Another study showed similar results to ours despite only rearing snails at the density of 900 snails/m^2 [20].

In this study, black apple snails were reared at water depth of 15 – 30 cm. In other studies, the snails were cultured at different water levels such as at 15cm[5], 30 cm[8], or 30 - 40 cm[7], however, the research results of these authors are lower than ours despite lower rearing densities. It is worth to notice that industrial foods or pellet foods were used in these studies while we used duckweed and fresh calabash. Thus, it can be speculated that not only water depths effect on growth of snails, but food also plays a very important role, and foods used in this study are suitable for black apple snails while industrial foods or pellet foods may not really proper.

3.3. Survival of black apple snails

In general, survival of snails during the experiment was very high, with a range of 97.17 – 98.17% (Table 4). At all examining times (10 days, 20 days and 30 days), survival of snails at 15 cm was always lower than that of 3 other treaments ($p<0.05$). At the end of experiment (30 days), survival of snails at 15 cm, 20 cm, 25 cm and 30 cm were 97.17%, 98.17%, 97.83% and 97.67% respectively. These values are quite similar to results of Diem et al.[6] when studied on the effects of different protein levels (15%, 20%, 25%, 30%, 35% and 40%) on growth and survival of snails (with 88.4% at 40% protein to 98.0% at 20% protein), or Thao et al. (95.83% - 99.33%)[7]. Binh and Thao[5] also reported similar survival rate compared to our results when rearing snails at density of 300 individuals/m^2 (97.1%) but lower at other densities (600, 900 and 1200 snails/m^2). Other studies also showed lower survival rates of snails, eg. 66.7 - 88.3%[20] or 34.7% - 76.7%[8]. Thus, it can be seen that the survival rate of snails in our study is much higher than other studies[5,8,20], proving that snails adapt well to the rearing conditions and foods. We reared them in tanks and used duckweed and fresh calabash as food. Although Thao and Binh[8] reported that pH = 8 was a suitable value for black apple snails during the rearing stage, it was clear that the survival rate was quite low compared to our results. This suggests that the authors might use inappropriate food or the addition of aluminum alum to reduce the pH could affect the survival of snails.

Table 4. The survival of black apple snails at different water levels

	Water depths

Rearing time (days)	15 cm	20 cm	25 cm	30 cm
0	100 ± 0.00	100 ± 0.00	100 ± 0.00	100 ± 0.00
10	97.67 ± 0.29^{b}	99.00 ± 0.87^{a}	98.33 ± 0.58^{a}	98.67 ± 0.58^{a}
20	97.17 ± 0.29^{b}	98.17 ± 0.76^{a}	97.83 ± 0.29^{a}	97.67 ± 0.29^{a}
30	97.17 ± 0.29^{b}	98.17 ± 0.76^{a}	97.83 ± 0.29^{a}	97.67 ± 0.29^{a}

Note: In the same row, the different superscritp letters indicate the significant difference ($p<0.05$). n=3.

CONCLUSION

The environment factors in the experiment were suitable for the black apple snails. The height and weight of snails were biggest at water depth of 30 cm (12.87 mm and 0.495 g respectively) while the width of snails reached the highest value at 25 cm and 30 cm (9.62 mm and 9.59 mm respectively). The survival rate of snails was very high (97.17 – 97.83%) and the snails reared at 20 cm, 25 cm and 30 cm had higher survival rate than that of 15 cm. In general, the water depth of 30 cm is the most suitable for black apple snails in rearing condition.

REFERRENCE

1. Ngo Thi Thu Thao and Nguyen Thi Nha Trang. Effects of light conditions on the hatching rate, growth and survival rate of black apple snail (*Pila polita*), *Journal of Science - Can Tho University*, **2015**, *38*(1), 73-79.
2. Vo Xuan Chu. *Study on some biological characteristics and trial seed production of the black apple snail Pila polita*. Master thesis in Biology. Tay Nguyen University, 2011.
3. Le Van Binh and Ngo Thi Thu Thao. Some reproductive biological characteristics of black apple snails distributed in Mekong Delta. *Journal of Science - Can Tho University*, **2020**, *56*, (2B), 117-126.
4. Phan Dinh Phuc, Vo Xuan Chu. Study on some biological characteristics of black apple snails *Pila polita* in Dak Lak, *Vietnam Journal of Agricultural Sciences*, **2014**, 106-112.
5. Le Van Binh and Ngo Thi Thu Thao. Effect of different stocking densities on growth and survival rate of black apple snail larvae (*Pila polita*), *Journal of Science - Can Tho University*, **2014**, *1*, 83-91.
6. Vo Thi Kieu Diem, Le Van Binh, Ngo Thi Thu Thao, Nguyen Tri Thanh and Nguyen Anh Tuan. Effects of different protein contents in diet on the growth and survival rate of black apple snail (*Pila polita*), *Journal of Science - Can Tho University*, **2018**, *54*(3B), 177-185.
7. Ngo Thi Thu Thao, Dang Van Danh, Le Van Binh. Effect of supplementation of yucca formulation on growth and survival rate of black apple snail (*Pila polita*), *Vietnam Journal of Agricultural Sciences*, **2023,** *21*(7), 834-842.
8. Ngo Thi Thu Thao and Le Van Binh. Effect of pH on the results of hatching snails (*Pila polita*), *Journal of Agriculture and Rural Development*, **2018**, *2*, 111-175.
9. Olena Uvayeva, Tetiana Vakaliuk, Georgiy Shcherbina, and Elena Shimkovich. Sexual dimorphism in shell morphology of mollusks of the genus *Viviparus* – important objects of water resources of Ukraine, *E3S Web of Conferences*, **2021**, *280*, 10011.
10. Lum-Kong, A. and Kenny, J.S. The reproductive biology of the ampullariid snail *Pomacea urceus* (Müller). *Journal of Molluscan Studies*, **1989**, *55*, 53-65.
11. Boyd, C.E. *Water Quality in pond for aquaculture*. Department of Fisheries and Allied Aquaculture Auburn University Alabama 36849 USA, 1998.
12. Santhosh, B. and Singh, N.P. *Guidelines for water quality management for fish culture in Tripura*, ICAR Research Complex for NEH Region, Tripura Center, Publication no.29, 2007.
13. Truong Quoc Phu, Vu Ngoc Ut. *Water quality management in fresh water ponds*, Publishing house of Agriculture, 2012.
14. Wurts, W.A. and Durborow, R. M. *Interactions of pH, carbon dioxide, alkalinity and hardness in fish ponds southern regional aquaculture center*, SRAC Publication No. 464, 1992.
15. Bhatnagar, A., Jana, S.N., Garg, S.K. Patra, B.C., Singh, G. and Barman, U.K. *Water quality management in aquaculture, In: Course Manual of summer school on development of sustainable*

aquaculture technology in fresh and saline waters, CCS Haryana Agricultural, Hisar (India), 2004.
16. Bhatnagar, A. and Singh, G. Culture fisheries in village ponds: a multilocation study in Haryana, India. *Agriculture and Biology Journal of North America*, **2010**, *1*(5), 961-968.
17. Ekubo, A. A. and Abowei, J. F. N. Review of some water quality management principles in culture fisheries, *Research Journal of Applied Sciences, Engineering and Technology*, **2011**, *3*(2), 1342-1357.
18. Robinette, H. R. Effect of selected sublethal levels of ammonia on the growth of channel catfish (*Ictalurus punctatus*), *Progressive Fish Culturist*, **1976**, *38*, 26-29.
19. National standards – TCVN13952:2024, *Water for aquaculture - Freshwater - Quality Requirements*, Ha Noi, 2024.
20. Tran Van Tam. *Research to complete the technical process of seed production and commercial farming of black apple snail (Pila polita) in Hung Yen province*, The report of provincial project, 2022.