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Research Article

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Experimental Nursing and Grow-Out of Commercial Snakehead Fish (Channa Striata Bloch, 1793) From Three Different Brood Stock Sources

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ABSTRACT
The experiment on nursing and grow-out of commercial snakehead (Channa striata Bloch, 1793) from three different brood stock sources was conducted from July 2024 to March 2025 in Chau Phu district, A Giang province. Results after 60 days of nursing indicated that larvaes originating from Vietnam, Cambodia, and Thailand exhibited relatively high performance, with growth ranging from 2.5 ± 0.1 g/fish to 3.1 ± 0.1 g/fish, survival rates ranging from 50.3 ± 7.5% to 57.3 ± 10.2%, and feed conversion ratios (FCR) ranging from 0.83 ± 0.06 to 0.89 ± 0.03.

In the grow-out phase, snakehead originating from Vietnam and Thailand showed higher growth rates and productivity, with statistically significant differences ($p<0.05$) compared to those from Cambodia. However, survival rates of the Cambodian stock were significantly higher than those of the Vietnamese and Thai stocks ($p<0.05$).

These findings suggest that the three brood stock sources, originating from different ecological regions, display technical differences during nursing and grow-out. Nevertheless, the obtained values can be practically applied to local production systems, providing suitable seed production and commercial grow-out models for farmers in the Mekong Delta region.

Keywords: Nursing, Grow-Out, Growth Performance, Survival Rate, Productivity

Introduction

Alongside traditional cultured fish species such as Tra catfish, Clarias catfish, Basa catfish, and Climbing perch, Snakehead (Channa striata Bloch, 1793) has become an important aquaculture species in the Mekong Delta. This freshwater species possesses high economic value due to its desirable flesh quality, large size, and rapid growth rate, thereby contributing significantly to improving livelihoods in provinces such as A Giang, Dong Thap, Can Tho, and Ca Mau [1].

In recent years, although domestic market demand for snakehead remains relatively high due to consumer preference, the practice of seed production and commercial culture of snakehead in the Mekong Delta particularly in A Giang province has shown a declining trend in terms of both farming area and farmer participation. This decline is largely attributable to limitations within seed production models that negatively affect quality and overall efficiency. Challenges include low reproductive capacity, small egg size during maturation and spawning, low fertilization and hatching rates (< 70%), low survival rates of larvaes during nursing (<30%), high disease susceptibility, relatively slow growth during grow-out, and an increasing proportion of deformed larvaes and juveniles during production (>7%).

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These issues result in prolonged grow-out periods (>7 months), deterioration of nursing systems, rising production costs, and fluctuating markets, ultimately leading to reduced financial efficiency of snakehead farming [2].

Therefore, research and application of selective breeding technologies for snakehead play a crucial role in improving brood stock quality, seed performance, growth, and reproductive traits. Such efforts carry significant economic and social implications, contributing to increased profitability for producers. However, up to now, no scientific research has been conducted in A Giang province to develop quality-oriented selective breeding and production models aimed at overcoming these technical limitations. Importantly, such studies would provide a scientific basis for conserving native fish genetic resources while meeting the production demands of local farmers.

In this context, an experiment on nursing and commercial grow-out of snakehead from three different brood stock sources (Vietnam, Cambodia, and Thailand) was conducted. The study aimed to provide preliminary insights into survival and growth performance under the ecological conditions of the Mekong Delta, thereby establishing a theoretical basis for improving snakehead fingerlings quality through technical interventions using brood stock from different origins (Vietnam, Cambodia and Thailand) in A Giang province.

Research Methods

Study Period and Location

The experiment was conducted from July 2024 to March 2025 in Chau Phu District, An Giang province, Vietnam.

Research Methods

Experimental Subjects

Snakehead larvaes and fingerlings from Vietnam, Cambodia, and Thailand used in this study were produced from brood stock collected from three different sources: An Giang province (Vietnam), Tonle Sap Lake (Cambodia), and rice fish farming systems in Ubon Ratchathani province (Thailand).

After collection, brood stock was reared in maturation ponds. During the first 1 - 3 days of acclimation, no feed was provided. From days 4 – 15, brood stock was fed with trash fish at a ratio of 0.5 - 1% of body weight. From days 16 – 90 of the maturation phases, they were fed pelleted feed (size of 4 – 6 mm, 42% protein) at 2 - 3% of body weight per day. After 90 days of maturation, brood stock was checked for gonadal maturity and subsequently induced to spawn.

Experimental Design

Experiment 1: Nursing snakehead larvaes in earthen ponds using different sources

Snakehead larvaes (hatched after 28 - 30 hours) from Vietnam, Cambodia, and Thailand were transferred to nursing ponds, each with an area of 20 m²/pond. The experiment consisted of three treatments with six replications each:

- **Treatment 1 (T1):** Larvaes from Vietnam
- **Treatment 2 (T2):** Larvaes from Cambodia
- **Treatment 3 (T3):** Larvaes from Thailand

Figure 1: Earthen ponds for nursing fingerlings of Channa striata from 3 different sources

The nursing density was 500 larvaes/m², and the nursing period lasted 60 days. Prior to stocking, ponds were prepared according to the technical guidelines of the Ministry of Agriculture and Rural Development of Vietnam.

Management and feeding: Water depth was maintained at 1.0 - 1.2 m. From days 5 - 7 after stocking, 20 - 30% of the pond water was replaced to stabilize water quality and maintain dissolved oxygen levels. Subsequently, 40 - 50% of pond water was exchanged every 7 - 10 days. Feeding regimes included: days 1 - 7: Moina; days 8 - 20: supplemented with finely ground commercial feed (42% protein); days 21 - 60: pelleted feed (0.3 - 0.5 mm, 42% protein). Fish were fed 2 - 3 times daily. After 60 days, all fingerlings were harvested with hand nets, and technical parameters including survival rate, growth, and productivity were recorded.

Experiment 2: Commercial grow-out of snakehead in net hapas installed in earthen ponds with different larvaes sources

The commercial grow-out experiment consisted of three treatments corresponding to three fingerlings sources (Vietnam, Thailand, and Cambodia). Each treatment had three replicates, arranged randomly in nine hapas. Each hapas had an area of 30 m² and was installed in a 2,000 m² earthen pond with a water depth of 1.6 – 2.0 m.

- **Treatment 1 (T1):** Fingerlings from Vietnam
- **Treatment 2 (T2):** Fingerlings from Thailand
- **Treatment 3 (T3):** Fingerlings from Cambodia

Figure 2: Hapas used for practical snakehead (Channa striata) culture

Stocking density was 90 fish/m², with snakehead fingerlings sized 200 – 300 individuals/kg, stocked in the morning between 8:00 – 9:00 a.m. During the grow-out stage, fish were fed commercial pellets containing 42% protein, at a daily ration of

3–7% of body weight. Every 7–10 days, vitamin C (50 mg/kg feed) and premix (1-1.5% of feed weight) were supplemented to enhance fish health and immunity. After six months of culture, all fish reared in net hapas installed in ponds from the different brood stock sources were sampled and harvested. The results served as the basis for calculating technical parameters such as growth, survival, and feed conversion ratio (FCR).

Culture system management

Water Quality Parameters

Water quality parameters in experimental ponds were sampled every 15 days during the nursing stage and every 30 days during the grow-out stage, including: water temperature (measured with a thermometer), pH and dissolved oxygen (measured at the inlet, middle, and outlet of the pond using Sera test kits, Germany). Total ammonia nitrogen (TAN) was analyzed by spectrophotometric colorimetric at the Water Analysis Laboratory, School of Aquaculture and Fisheries, Can Tho University [3].

Growth sampling of nursing fish was carried out using a hand net, with 30 fish/pond randomly collected each time for weight measurement. For grow-out fish, samples were taken with a cast net, collecting 30 fish/hapas at random for weight determination. The survival rate and yield were determined after harvested.

* Technical specifications of the nursing and grow-out systems

Daily weight gain - DWG (g/day):

$DWG\ (g/\text{day}) = (W_2 - W1)/(t_2 - t_1)$

Where: W2: Fish weight at time t2 and W1: Fish weight at time t1

- **Survival rate (%)** = (Number of fish harvested / Number of fish stocked) × 100
- **Feed conversion ratio (FCR)** = Feed intake (kg) / Weight gain (kg)
- **Yield (kg/m², ha)** = Total fish weight harvested (kg) / Pond area (ha)

Data analysis

All collected data were expressed as mean ± standard deviation (SD) using Microsoft Excel 2016. Statistical differences among treatments were tested by one-way ANOVA. Data were processed using IBM SPSS Statistics version 20.0.

Results and Discussions

Nursing Performance of Snakehead Larvaes to Fingerlings from Different Sources

Environmental Factors during Nursing

Water quality parameters recorded during the nursing period (Table 1) showed that water temperature in the nursing ponds ranged from 29 – 30°C. According to Duong Nhut Long et al., the optimal temperature range for snakehead growth and development across different aquatic environments is 27 – 30°C [4]. Moreover, snakehead is a species capable of tolerating wide fluctuations in water temperature. Therefore, the recorded temperature values in this experiment were not considered to negatively affect the growth and development of snakehead fingerlings during the nursing stage.

Table 1: Water quality parameters during phase of larvaes nursing

Factors	Fish sources	Nursing time (days)				
		Init.	15	30	45	60
Water temperature (t^0C)	Vietnam	29	29,5	30	29,5	30
	Campuchia	29	29,5	30	29,5	30
	Thailand	29	29,5	30	29,5	30
Water pH	Vietnam	7,3	7,5	7,8	8,2	8,1
	Campuchia	7,5	7,4	7,7	8,1	8,2
	Thailand	7,5	7,2	7,5	8,1	8,4
DO (mg/l)	Vietnam	4,3	4,8	5,1	5,2	4,7
	Campuchia	3,9	4,6	4,8	5,1	4,9
	Thailand	4,2	4,5	4,7	4,6	4,8
TAN (mg/l)	Vietnam	0,07	0,5	0,7	0,9	1,1
	Campuchia	0,05	0,6	0,8	0,9	0,9
	Thailand	0,04	0,6	0,9	0,8	0,9

The pH values recorded in the experimental ponds ranged from 7.2 to 8.4, which is considered suitable for the nursing of many fish species (Truong Quoc Phu, 2006) [4-6]. Dissolved oxygen (DO) levels in the experimental ponds were relatively high, ranging from 3.9 to 5.2 mg/L. According to Boyd, dissolved oxygen levels above 3 mg/L are appropriate for most aquaculture species [5].

Total ammonia nitrogen (TAN) during the experiment ranged from 0.04 to 1.1 mg/L. By the end of the nursing stage, as fish exhibited rapid growth and increased feed intake, waste accumulation in the environment also rose, leading to higher TAN levels across treatments (0.9 – 1.1 mg/L). However, these values remained within the acceptable threshold (≤ 2 mg/L) that does not adversely affect the survival and development of snakehead fingerlings.

In water quality management of nursing ponds, partial water exchange at a rate of 30 – 50%, combined with the application of 2–3 kg of lime powder for water treatment, was an effective and safe approach to maintaining optimal water conditions for snakehead larvaes and fingerlings.

Growth, survival rate, and feed conversion ratio (FCR) of snakehead fingerlings

The results of growth assessment for snakehead during the nursing stage are presented in Table 2. After two months of nursing, fingerlings originating from Vietnam reached the highest average weight of 3.1 ± 0.1 g/fish, showing a statistically significant difference ($p < 0.05$) compared to fingerlings from Cambodia, which averaged 2.5 ± 0.1 g/fish, and fingerlings from Thailand, which averaged 2.6 ± 0.1 g/fish and also differed significantly ($p < 0.05$).

The observed differences can be mainly attributed to the long-term domestication and adaptation of the Vietnamese brood stock, in contrast to the Thai stock reared under rice–fish farming conditions and the Cambodian brood stock collected from the wild in Tonle Sap Lake, which retain higher genetic diversity and wild traits. Conversely, the growth differences between Cambodian and Thai fingerlings were not statistically significant ($p > 0.05$).

Table 2: Technical parameters during phase of larvae nursing of Channa striata

N⁰	Fish sources	Growth (g/fing.)	Survival rate (%)	FCR
1	Vietnam	3,1±0,1[c]	50,3±7,5[a]	0,87±0,05[bc]
2	Campuchia	2,5±0,1[a]	53,7±6,3[bc]	0,83±0,06[a]
3	Thailand	2,6±0,1[ab]	57,3±10,2[c]	0,89±0,03[c]

Note: The values are presented as mean ± standard deviation. Values in the same column with different letters indicate statistically significant differences ($P < 0.05$)

During the nursing period, snakehead fingerlings from Vietnam exhibited the highest growth rate, reflecting their adaptive advantage to environmental conditions over multiple generations. In contrast, fingerlings from Thailand and Cambodia, which retain higher wild behavioral traits, required a period of acclimation to the nursing and maturation environments. As a result, the growth of these fingerlings was lower compared to the Vietnamese stock.

At the end of the 60-day nursing stage, survival rates of Vietnamese fingerlings were the lowest at 50.3 ± 7.5%, showing a statistically significant difference ($p < 0.05$) compared to Cambodian fingerlings (53.7 ± 6.3%) and Thai fingerlings (57.3 ± 10.2%). The survival rates between Cambodian and Thai fingerlings were not significantly different ($p > 0.05$). These results indicate that survival during nursing is influenced by multiple factors, including water quality, predation, competition for feed, and cannibalism. Observations from nursing ponds with different fingerling sources suggest that cannibalistic behavior is an important factor contributing to differences in survival rates among the stocks.

Analysis of feed conversion ratio (FCR) showed that fingerlings from Cambodia had the lowest average FCR (0.83 ± 0.06), significantly different ($P < 0.05$) from Vietnamese (0.87 ± 0.05) and Thai fingerlings (0.89 ± 0.03). However, the difference in FCR between Vietnamese and Cambodian fingerlings was not statistically significant ($p > 0.05$).

These results indicated that the nursing experiment achieved good FCR values compared to previous studies on snakehead fingerlings [4]. The findings also provide theoretical support for effective nursing practices, including pond preparation, proper care and management, and provision of high-quality feed, especially live feed such as Moina. These factors were crucial in promoting rapid growth, reducing cannibalism, and improving feed utilization efficiency during the nursing stage.

Results Of Grow - Out Culture of Snakehead from Three Different Sources

Water Quality Characteristics of the Culture System

During the grow-out phase of snakehead cultured in hapas placed within earthen ponds, water quality parameters were recorded as follows: water temperature ranged from 27.7 ± 0.1°C to 32.4 ± 0.3°C; pH ranged from 7.4 ± 0.2 to 7.8 ± 0.2; dissolved oxygen (mg/L) fluctuated between 4.7 ± 0.7 and 5.3 ± 0.7 mg/L; and total ammonia nitrogen (TAN) ranged from 1.2 to 1.7 mg/L.

Since the experimental hapas of all treatments were placed within the same pond, the ecological and environmental conditions of the system were relatively homogeneous. With a common water supply from the irrigation canal, water quality throughout the experiment remained fairly stable. Variations in water quality parameters among treatments were minimal and did not exert adverse effects on the survival or growth performance of cultured snakehead.

Growth rate, survival rate, and yield of marketable snakehead

Growth Performance in the Culture Model

Table 3: Technical parameters during the grow-out culture of snakehead (Channa striata) from three different sources

Fish sources	Initial W (g/f)	End W (g/f)	Survival rate (%)	Yield (kg/m²)	FCR
Vietnam	3,1± 0,1[a]	602,2± 45,7[ab]	77,1± 0,4[a]	46,1± 3,7[c]	1,34 ± 0,01[a]
Campuchia	3,05± 0,1[a]	381.8± 102,3[a]	86,3± 4,2[c]	29,6± 7,5[a]	1,41 ± 0,04[c]
Thailand	2,95± 0,1[a]	664.2 ± 55,9[b]	81± 1,7[b]	43,9± 4,2[b]	1,36 ± 0,01[b]

Note: Values are presented as mean ± standard deviation. Values within the same column followed by different letters are significantly different ($p < 0.05$)

The experimental results showed that snakehead fish cultured from the Cambodian source reached an average weight of 381.8 ± 102.3 g/fish, which was significantly lower ($p < 0.05$) compared to the Vietnamese source (602.2 ± 45.7 g/fish) and the Thai source (664.2 ± 55.9 g/fish, $P > 0.05$). Snakehead fish from the Cambodian source exhibited the lowest average weight (381.8 ± 102.3 g/fish), while fish from the Thai source reached the highest average weight (664.2 ± 55.9 g/fish), with a statistically significant difference ($p < 0.05$). During the culture period, snakehead from the Cambodian source still displayed strong wild traits, with shy behavior and relatively slow response when approaching feed provided by humans. Their slow feeding behavior reduced nutrient absorption efficiency, leading to slower growth rates compared to the other sources [7].

In contrast, snakehead from Vietnam and Thailand demonstrated better adaptability to the culture environment and exhibited more active feeding behavior, thereby promoting faster growth rates.

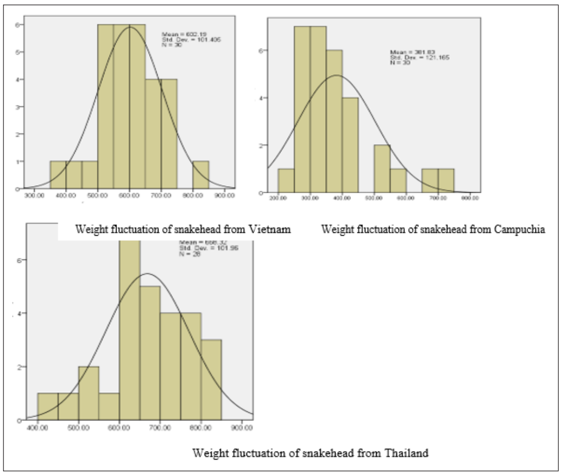

Figure 3: Weight fluctuation of cultured snakehead from 3 different sources

Analysis of weight differentiation of cultured snakehead fish (Channa striata) from the three sources (Vietnam, Cambodia, and Thailand) showed that, for the Vietnamese source, fish weighing < 500 g/individual accounted for 10%, those weighing 500–600 g/individual accounted for 40%, and those > 600 g/individual accounted for 50%. In the Cambodian source, fish < 500 g/individual represented 83.3%, those between 500–600 g/individual accounted for 10%, and fish > 600 g/individual accounted for only 6.7%. For the Thai source, fish < 500 g/individual made up 6.7%, those weighing 500 - 600 g/individual 13.3%, while the majority (80%) weighed > 600 g/individual.

The analysis indicated that, within and among populations from different sources, there was marked weight differentiation, reflected by the presence of multiple size groups. This demonstrates that growth rates within populations were not uniform, potentially influenced by differences in ecological distribution in natural habitats, high feeding competition due to carnivorous feeding behavior, or genetic factors [8,7]. These were identified as the main drivers of size variation in cultured snakehead populations.

In practical aquaculture, using size grading by seine netting after two months of culture model is a recommended management practice, contributing to reduced feed costs, improved growth, and enhanced production efficiency [4].

Survival Rate, Yield, and Feed Conversion Ratio of Snakehead Cultured from Three Brood Stock Sources

The assessment of survival rates of market-size snakehead (Channa striata) after 180 days of culture from different brood stock sources (Table 3) revealed significant variation. Fish originating from Vietnam exhibited the lowest survival rate (77.1 ± 0.4%), followed by those from Thailand (81.0 ± 1.7%), while the Cambodian source achieved the highest survival rate (86.3 ± 4.2%) ($P < 0.05$). Although survival rates differed among treatments, they remained relatively high overall. Notably, snakehead from Cambodia demonstrated superior resilience, likely attributable to their broader genetic diversity and natural distribution compared with the Vietnamese and Thai populations. These traits represent key adaptive advantages under fluctuating environmental conditions associated with climate change, limited natural food availability, reduced nutrient assimilation, impaired growth performance, and increased disease susceptibility all of which can negatively affect productivity and model efficiency.

When benchmarked against survival rates of other cultured freshwater species such as Acrossocheilus spp. (73.7 – 81%; Duong Nhut Long et al., 2023), snakeskin gourami (Trichopodus pectoralis) (80.9 – 89.8%; Nguyen Hoang Thanh et al., 2021), and climbing perch (Anabas testudineus) (60 - 80%; Duong Thuy Yen, 2013) the survival rates of snakehead across brood stock sources can be considered comparatively high. This provides a valuable technical dataset with critical implications for yield, product quality, and overall culture efficiency.

After six months of culture, harvest data (Table 3) showed mean yields of 29.6 ± 7.5 kg/m² for the Cambodian source, 43.9 ± 4.2 kg/m² for the Thai source, and 46.1 ± 3.7 kg/m² for the Vietnamese source ($P < 0.05$). As highlighted by Duong Nhut Long et al., fish production in aquatic systems is strongly influenced by factors including water quality, seed size, stocking density, survival rate, feed quality, growth potential, and health management practices [4]. Accordingly, the observed differences in snakehead yields in this study may be attributed to intrinsic disparities in brood stock quality, reflected in their growth performance and survival rates.

Furthermore, the findings underscore the importance of domestication and biological adaptation of snakehead. When effectively managed, these processes not only generate substantial economic benefits but also contribute to advances in brood stock quality, selective breeding, and genetic improvement programs. Such efforts hold both biological and ecological significance while promoting the sustainable development of snakehead aquaculture [9].

Conclusions

- Snakehead populations from Vietnam, Cambodia, and Thailand, although geographically distinct, all satisfy essential biological and technical criteria, thereby contributing significantly to both seed production and commercial farming within the broader context of genetic improvement strategies.
- In the experimental model of snakehead (Channa striata) culture using brood stock from three different geographic sources, fish derived from Vietnam and Thailand exhibited superior growth performance and yield. Specifically, the Vietnamese stock reached 602.2 ± 45.7 g/fish with a production yield of 46.1 ± 3.7 kg/m², while the Thai stock attained 664.2 ± 55.9 g/fish and 43.9 ± 4.2 kg/m². These values were significantly higher than those for the Cambodian stock, which reached only 381.8 ± 102.3 g/fish and 29.6 ± 7.5 kg/m². Nevertheless, snakehead from the Cambodian source showed the highest survival rate (86.3 ± 4.2%) compared with both the Vietnamese and Thai sources. Importantly, the Cambodian stock also exhibited strong vitality and high genetic diversity, highlighting its potential contribution to selective breeding programs aimed at improving the genetic quality of cultured snakehead.

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