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Research Article

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Building Technical Protocol for Artificial Propagation and Commercial Farming of Fish (Onychostoma Gerlachi Peters, 1881) in Kon Plong District - Kon Tum Province

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ABSTRACT

The research title "Building technical protocol for artificial propagation and commercial farming of fish (Onychostoma gerlachi Peters, 1881) in Kon Plong District, Kon Tum Province" was conducted from 2019 – 2021 with the aim of "to build successfully developing technical protocols for artificial propagation and commercial farming of fish to enable their application in practice, conserve, and sustainable development the fish resources in Kon Plong District, Kon Tum Province".

Research results showed that in practical experiments using hormonal treatments to stimulate artificial propagation, HCG injected alone at a dosage range of 1,500–3,000 IU/kg female fish failed to induce ovulation. However, using a combined treatment of LHRHa + Domperidone (100 µg + 10 mg Domperidone per kg female fish) successfully induced final oocyte maturation and egg release, yielding a fertilization rate of 82.6 ± 3.4%, a hatching rate of 77.1 ± 3.6%, and a fecundity of 50,312 ± 18,392 eggs/kg female fish. In the fingerling nursing experiments, a stocking density of 1,000 fish/m² achieved better growth (1.8 ± 0.24 g/fish) and survival (21.6 ± 2.5%) compared to a stocking density of 1,500 fish/m², which resulted in lower growth (1.1 ± 0.3 g/fish) and survival (11.3 ± 2.7%). In the commercial grow-out practical experiments, fish fed a formulated feed containing 30% protein exhibited higher growth (60.3 ± 5.7 g/fish), survival (81.0 ± 2.0%), and yield (4,894 ± 558 kg/ha ($P < 0.05$) compared with those fed a 25% protein feed, which resulted in a lower average weight (46 ± 6.3 g/fish), survival (73.7 ± 5.9%), and yield (3,367 ± 215 kg/ha).

This research successfully building protocols for fish artificial propagation and commercial farming of Onychostoma gerlachi was significant contributions to the conservation and restoration of this native fish species. The results enable farmers to reliably produce fingerling for aquaculture, providing income and improved livelihood opportunities.

Keywords: Brood Stock Maturity, Artificial Propagation, Hormone, Larvae, Stocking Density

Introduction

Fish of Onychostoma gerlachi Peters (1881) is one of the native fish species with economic value in Kon Tum Province. According to Yinggui Dai, this species has a morphology quite similar to carp but is more elongated, reaching a length of 15–25 cm when mature [1]. Its body is laterally compressed, silvery in color, and its fins have a faint golden tint that shines under the sun. The species feeds on moss and algae attached to rock surfaces. Its meat is delicious, with a mild bitter taste characteristic of fish inhabiting natural habitats, making it highly sought after by local people, which has led to overexploitation and depletion of its wild populations. Meanwhile, studies conducted on this species, both globally and in Vietnam, remain

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limited, focusing mainly on its morphology, taxonomy, and biodiversity. According to the IUCN Red List, Onychostoma gerlachi is classified as near threatened, with a high risk of extinction in the wild due to approximately a 30% population decrease in the Mekong and Chao Phraya rivers [2]. Therefore, researching hormonal injection for artificial propagation is an important technical solution for the conservation and restoration of this native fish species [3]. At the same time, combining this approach with commercial grow out farming systems is a practical and effective measure for domestication and for producing quality fingerlings for aquaculture [4].

Consequently, the research title "Building technical protocols for fish artificial propagation and commercial grow out of Onychostoma gerlachi Peters (1881) in Kon Plong District, Kon Tum province" aims to enable proactive fingerlings production for aquaculture, to create income enhancing opportunities for local communities, and contribute to the conservation and restoration of the native fish species' genetic resources.

Materials and Methods

Time and Research Sites

The research was conducted from August 2019 to April 2021 in Dakring village, Kon Plong District, Kon tum province. The brood stock used for culture maturation had an individual weight of 80 – 100 g/fish and were collected from local fishers in natural habitats within Kon Plong District, Kon Tum province. The fish were kept in earthen ponds with the total area range from 90 – 120 m² per pond with a stocking density of 0.3 kg/m², using commercial pellet feed containing 42% protein supplemented with 1% vitamin ADE. The feeding rate was 3–5% of total body weight per day, supplied twice daily. After three months of maturity culture, the brood stock was checked for sexual maturity and then used for fish artificial propagation. The resulting larvae were harvested and used for nursing fingerlings and culturing commercial grow out experiments in the field.

Research Methods

Fish Artificial Propagation Techniques for Onychostoma Gerlachi

Research on fish artificial propagation of Onychostoma gerlachi was conducted using two experiments with different hormonal and stimulant treatments of HCG and LHRHa + Domperidone.

- **Experiment 1:** Using hormone (HCG) injected four treatments: treatment 1 (1,500 IU/kg female), treatment 2 (2,000 IU/kg female), treatment 3 (2,500 IU/kg female), and treatment 4 (3,000 IU/kg female). The dosage for males was 1/3 of that injected to females.
- **Experiment 2:** Using stimulant (LHRHa + Domperidone) injected four treatments: treatment 1 (40 µg + 4 mg Dom)/kg female, treatment 2 (60 µg + 6 mg Dom)/kg female, treatment 3 (80 µg + 8 mg Dom)/kg female, and treatment 4 (100 µg + 10 mg Dom)/kg female.

Brood stock was selected based on external characteristics: mature females had a rounded, soft belly, a slightly reddish genital opening, and a high proportion (~70%) of evenly sized eggs. The eggs were pale yellow, spherical, free flowing, and lacked large blood vessels. The egg diameter ranged from 1.6 – 1.8 mm. The brood stock males were elongated and colorful, releasing milt upon gentle pressure to the abdomen. The breeding experiments were conducted in 1 m³ tanks with four replicates, with a flow rate of 0.2–0.3 m/s and continuous aeration. After injection, fish were monitored for ovulation, stripped, and fertilized artificially. The eggs were incubated in plastic trays with water slow flow until hatching.

Technical nursing of Onychostoma Gerlachi

Three day old larvae were nursed in 6 earthen ponds with two treatments of densities: 1,000 and 1,500 larvae/m² with total area of 100 m²/each. Each treatment was conducted in three replicates, and the nursing for 60 days. The ponds were prepared following the technical procedures of the Ministry of Agriculture and Environment. Initial feeding relied on natural plankton, enhanced by applying organic fertilizer at a rate of 5–7 kg/100 m² every 7–10 days. After 12–15 days, the fry was supplemented with high protein feed (42%), at 1 – 3 kg/100 m²/day, and administered 2–3 times per day. The fingerlings were harvested after nursing for 2 months.

Technical Culture for Commercial Grow-Out of Onychostoma Gerlachi

The grow out experiments were conducted in six earthen ponds with total area of 150–200 m²/pond, using fingerlings of an average weight of 1.7 g/fish, stocked at a density of 10 fish/m². The experiments involved two pellet feed treatments with different protein levels: treatment 1 (25%) and treatment 2 (30%). The ponds were prepared following the technical protocol of the Ministry of Agriculture and Environment. Pellet feed was administered at a rate of 5–7% of fish's body weight per day and 1%/weekly vitamin C was supplemented to increase disease resistance for fish in culture systems. The fish were harvested after culture 6 months.

Water Environmental and Technical Parameters Monitored in Practical Experiments

Water quality parameters were sampled every 15 days for the nursery experiments and every 30 days for the grow out trials. The parameters included temperature, pH, dissolved oxygen (DO), and total ammonia nitrogen (TAN) (mg/L), analyzed at the College of Aquaculture and Fisheries, Can Tho University. The growth and survival data were collected following the same schedule for sampling. At each sampling, 30 fish were randomly collected per pond for weight measurement. The technical parameters were calculated included: (1) Egg release rate (%), (2) Effect time, (3) Daily weight gain (DWG) (g/day), (4) Survival rate (%), (5) Feed conversion ratio (FCR), and (6) Final yield (kg/ha).

Data Analysis

All of experimental data were compiled, calculated and analyzed by using Excel 2016 and SPSS version 20.0.

Results and Discussions

Research on the Use of Stimulants and Hormone to Induce Spawning O. Gerlachi

Environmental Factors in the Pond Water During the Spawning Study of Fish

During the spawning process, the water temperature obtained between the experimental trials with average of 18.4 ± 0.3 °C. According to Niconski (1951), the fish's body temperature only differs from the ambient water temperature by approximately 0.5–1.0 °C. The mean of water temperature range for most fish species is 20–30 °C, and the tolerable range is 10–40 °C. Temperatures above 40 °C or below 10 °C greatly reduce the survival rate of the species. The pH value across treatments averaged 8.6 ± 0.3. According to Truong Quoc Phu, the ideal pH range for aquatic species is 6.5–9.0. Water pH that is too high or too low could affect aquatic organisms, impacting embryonic development, nutrition, and reproduction process [5]. The average water dissolved oxygen (DO) in the experiments was 5.4 ± 0.3 mg/L. According to Boyd and Truong Quoc Phu, the water parameter of DO level of over 3 mg/L (> 3 mg/L) is suitable values for most fish species in culture systems. In conclusion, the water quality parameters recorded throughout the practical experiments indicate no adverse effects on the spawning and development of Onychostoma gerlachi [6,5].

Use of Hormone (Hcg) to Induce Spawning in Onychostoma Gerlachi

The results of using the HCG hormone to stimulate fish spawning of Onychostoma gerlachi are presented in Table 1:

HCG is a commonly used hormone that has been highly effective in inducing reproduction in many fish species such as mud carp, catfish, silver barb, and marble goby [7]. However, in this experiment, where HCG was stimulated at dosages of 1,500–3,000 IU/kg of female fish, none of the fish between all four treatments exhibited signs of egg maturation and ovulation within 36 hours post-injection. According to Pham Van Khanh, HCG also failed to stimulate reproduction in silver barb, even at high dosages. Meanwhile, for Chitala chitala, egg release occurs only when HCG is administered at a dose of 6,000 – 9,000 IU/kg female fish [8,9].

Table 1: Results of artificial spawning of Onychostoma gerlachi by using HCG hormone

Treatments	Number of brood stock (fish)	Number of fish spawning	Time to effect (h)	Fecundity (eggs/kg)	Fertilization rate (%)	Hatching rate (%)
1	4	-	-	-	-	-
2	4	-	-	-	-	-
3	4	-	-	-	-	-
4	4	-	-	-	-	-

Observations of egg development revealed low polar positioning of the egg, ranging only from 7–12% before spawning. This suggests that the HCG dosages used in the experiment were not strong enough to trigger egg maturation and ovulation. According to Pham Minh Thanh and Nguyen Van Kiem in artificial breeding of Pangasius catfish, HCG administered at higher dosages of 5,000–6,000 IU/kg female fish was effective for inducing reproduction [10]. Conversely, HCG administered at 1,500 IU/kg female fish had no effect on egg release in Clarias batrachus [10]. Meanwhile, HCG hormone stimulated at a dosage of 2,500 IU/kg female fish successfully induced artificial reproduction in Clarias macrocephalus [9]. According to Ngo Vuong Hieu Tinh, HCG stimulated at dosages of 2,000, 3,000, and 4,000 IU/kg female fish failed to induce egg release in Wallago attu [11]. Similarly, Haniffa & Sridhar found that an HCG dosage of 1,000 IU/kg was ineffective in inducing egg release in snakehead fish (Channa punctatus) as compared to the higher HCG dosages of 2,000–3,000 IU/kg [12].

From the results of these studies, it can be concluded that each fish species has a specific effective hormone and dosage range for inducing spawning. The use of HCG effected at dosages of 1,500–3,000 IU/kg female fish for Onychostoma gerlachi was insufficient for egg maturation and ovulation, potentially due to the nature of the HCG used (single hormone), the insufficient dosage, and the quality of the brood stock and environmental conditions affecting the fish's reproductive process [9].

Use of (LHRHa + Dom) Stimulate to Induce Spawning of Onychostoma Gerlachi

Results of using the stimulant (LHRHa + Dom) to induce spawning in Onychostoma gerlachi are presented in Table 2. The experimental results shown that in treatments 1, 2, and 3, with dosages ranging from 40–80 µg combined with 4–8 mg Dom per kg of female fish, there were no egg release that observed within 36 hours post-injection. Observation of egg development revealed that the egg nuclei were not polarized or only minimally polarized (5–7%), and the egg diameter averaged approximately 1.67 ± 0.02 mm. Hence, the dosage levels used in treatments 1, 2, and 3 were insufficient to stimulate egg maturation and releasing in Onychostoma gerlachi.

Table 2: Dosage of LHRHa + Dom (µg/kg + Dom) for Inducing Spawning in Onychostoma gerlachi

Parameters	Treatments			
	1	2	3	4
Percentage of fish spawning (%)	-	-	-	87,5
Time to effect (h)	-	-	-	6h37' - 9h42'
Fertilization rate (%)	-	-	-	82,6 ± 3,4
Hatching rate (%)	-	-	-	77,1 ± 3,6
Fecundity (eggs/kg female)	-	-	-	50.312 ± 18.392

Note: Fecundity: average ± standard deviation

However, the results presented in Table 2 and figure 1 demonstrate that when using the stimulator (LHRHa + Dom) at a dosage of (100 µg + 10 mg Dom)/kg female fish (treatment 4), the fish fully released their eggs within 6h37'– 9h42' post-injection, achieving an egg release rate of 87.5%, an average fertilization rate of 82.6 ± 3.4%, and an average hatching rate of 77.1 ± 3.6%. The average fecundity was 50,312 ± 18,392 eggs per kg female fish. Utilizing a high dosage of LHRHa + Dom for stimulating brood stock spawning has proven highly effective for artificial spawning in Onychostoma gerlachi. At the similar results have been observed in other species as well. According to Nguyen Thi Long Chau & Mai Dinh Bang, in the Asian Pangasius catfish, a dosage of (150 µg + 5 mg)/kg female fish resulted in a response time of 5h44'–7h38', yielding the highest fertilization and hatching rates of 67.28% and 77.63%, respectively [13].

According to Nguyen Van Trieu et al, in Kryptopterus bleekeri, a dosage of (70 µg + 3.5 mg Dom)/kg female fish achieved a 100% egg releasing rate, yielding fecundity of 188,365 eggs per kg, a fertilization rate of 77.67%, and a hatching rate of 92.23% [14]. According to Pham Minh Thanh and Nguyen Van Kiem, in walking catfish, egg release occurs 12–14 hours after injection of LHRHa + Dom at a dosage of (50 – 70 µg + 10 mg Dom)/kg female fish. In this study, artificial spawning of Onychostoma gerlachi was successfully achieved using LHRHa + Dom injected at a dosage of (100 µg + 10 mg Dom)/kg female fish [9].

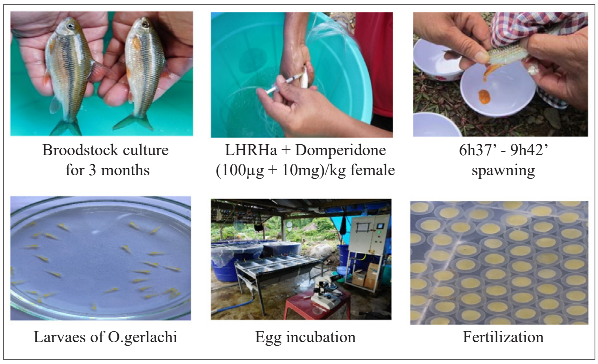

Figure 1: Artificial propagation technique for Onychostoma gerlachi

Experimental nursing of O. Gerlachi Larvaes in Earthen Ponds up to 60 Days

Water Quality Conditions in the Nursing Ponds

The water temperature in the fingerling nursing ponds ranged from 18.2 ± 0.4 ºC to 19.3 ± 0.3 ºC, pH ranged from 7.8 ± 0.6 to 8.6 ± 0.4, dissolved oxygen (DO) ranged from 4.8 ± 0.7 mg/L to 5.7 ± 0.3 mg/L, and total amonium (TAN) ranged from 0.03 ± 0.01 mg/L to 0.22 ± 0.06 mg/L. These data indicate that the water quality conditions in the nursing ponds were completely suitable and did not cause any adverse effects on the survival rate, growth or development of Onychostoma gerlachi fingerlings [6,5].

Growth of Onychostoma Gerlachi Fingerlings after 60 Days

Observations of the growth of Onychostoma gerlachi fingerlings, as shown in Figure 2, indicated that the fingerlings in treatment I (1,000 fish/m²) growth significantly faster ($p < 0.05$) compared to those in treatment II (1,500 fish/m²).

The differences in size and growth of Onychostoma gerlachi fingerlings between the two treatments were quite noticeable, especially from the 30-days nursing period until 60 days. At 60 days of nursing, the average weight of fingerlings in treatment I (1,000 fish/m²) reached 1.8 ± 0.24 g per fish, with a daily growth rate of 0.03 g/day, significantly higher ($P < 0.05$) than that of fingerlings in treatment II (1,500 fish/m²), which averaged 1.1 ± 0.3 g per fish and growth at 0.02 g/day. These results indicate that, under the same ecological conditions and with identical care and management practices, higher stocking densities could easily lead to increased competition for space and food within the nursing system, thereby negatively affecting both the growth rate and survival of the fingerlings [15,16].

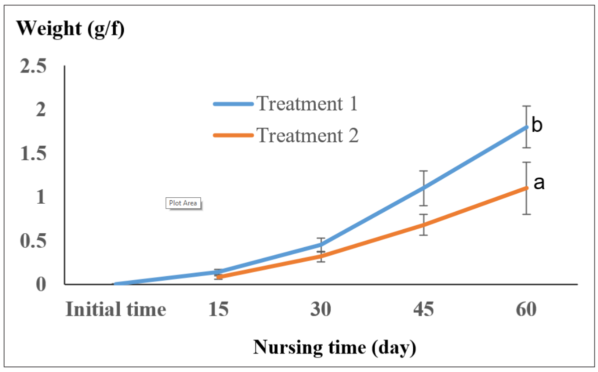

Figure 2: Growth of Onychostoma Gerlachi Fingerlings Reared in Ponds after 60 Days

This finding is consistent with an observation for the growth of Trichopodus pectoralis fingerlings in earthen ponds at a stocking density of 500 fish per m², where after 60 days of nursing, the fish reached an average weight of 2.29–4.39 g per fish [17]. In an experiment nursing of (Micronema bleekeri) fingerlings at different densities (1.5, 2.5, 3.5, and 4.5 fish/L), after 30 days the fish stocked at 1.5 fish/L showed significantly higher growth ($P < 0.05$) compared to those in the other treatment [18]. In practice, concerning to some carnivorous fish species, stocking density may not always have a significant impact on growth. For example, in an experiment with Wallago attu fingerlings, a predatory freshwater species, stocked at densities of 100, 200, 300, and 400 fish per 300 L tank, after 30 days of nursing, the average weights of fingerlings between treatments (13–15.3 g per fish) were not significantly different values ($P > 0.05$) [19]. In summary, it can be concluded that the available space for fish activity, the water quality, and natural food supply are critical factors influencing the growth of Onychostoma gerlachi fingerlings during the nursing phase [20].

Survival rate (%) of Onychostoma Gerlachi Fingerlings

At the end of the nursing period, the survival rate of fingerlings in treatment I was 21.6 ± 2.5%, significantly higher than that of fingerlings in treatment II (11.3 ± 2.7%) ($P < 0.05$).

Table 3: Survival rate (%) and feed conversion ratio (FCR)

Treatments	Survival rate (%)	FCR
Treatment I (1,000 fish/m²)	21.6 ± 2.5^{b}	1.08 ± 0.04^{a}
Treatment II (1,500 fish/m²)	11.3 ± 2.7^{a}	1.24 ± 0.07^{b}

Note: Values are presented as mean ± standard deviation. Means within the same column followed by the same letter are not significantly different ($p > 0.05$).

According to Pham Minh Thanh and Nguyen Van Kiem (2009), the quality and survival rate (%) of almost freshwater fish species during nursing depend on various factors, including the natural feed and the space available for the fish, which are among the primary factors affecting survival and growth quality. According to Phan Phuong Loan, when studying the effects of different stocking densities of Mastacembelus favus in composite tanks: 500 fish/m³ (treatment I), 1,000 fish/m³ (treatment II), and 1,500 fish/m³ (treatment III) after 60 days of nursing, the survival rate of fish in treatment II was 64.27%, higher than in treatment I (59.53%) and treatment III (51.53%) [21]. This experiment demonstrated that varying stocking densities significantly impacted fish behavior, feeding activity and different growth rate.

Feed conversion Ratio (FCR)

After 60 days of nursing, the FCR for Onychostoma gerlachi fingerlings in treatment I was 1.08 ± 0.04, lower than the FCR in treatment II (1.24 ± 0.07). When comparing these FCR values with those recorded for Pangasius (Hai et al., 2022), where FCR ranged from 0.9–1.0, it is evident that the FCR for Onychostoma gerlachi fingerlings (1.08–1.24) is higher. This difference is largely attributed to species-related characteristics such as size, feeding behavior, and growth rate. Compared to pangasius, Onychostoma gerlachi is smaller and has a slower growth rate, resulting in a higher FCR. Additionally, the nursing environment for Onychostoma gerlachi is a flowing water environment with low natural food biomass, requiring fish to expend more energy swimming and foraging for feed. In practice, this suggests the need for further research and implementation of measures that can help increase natural feed biomass and improve feed utilization efficiency during the nursing period.

Commercial Culture Farming System of Onychostoma Gerlachi

Water Environmental Factors in Commercial Culture System

Throughout the culture period, no significant fluctuations were observed in water quality parameters: water temperatures ranged from 18.5–22.1 ºC, pH values from 6.7–7.4, dissolved oxygen (DO) from 3.8–5.1 mg/L, and total ammonia nitrogen (TAN) ranged from 0.1–0.4 mg/L. The culture ponds were located in areas with similar natural ecological conditions and shared the same water source from an irrigation canal. As a result, water quality in the ponds remained stable, providing favorable conditions for the growth and development of Onychostoma gerlachi in commercial culture model.

Growth Of Onychostoma Gerlachi in Culture Ponds

Observations of fish growth between the two treatments (25% protein feed and 30% protein feed), as shown in Figure 3, indicated that the commercial-sized fish in treatment 2 (30% protein) achieved higher average weight and growth compared to those in treatment 1 (25% protein). At the end of the culture period, fish in treatment 2 reached an average weight of 60.3 ± 5.7 g per fish with a growth rate of 0.28 g/day, higher than the average weight of fish in treatment 1 (46 ± 6.3 g per fish) and growth rate of 0.21 g/day ($P < 0.05$). According to Pham Minh Thanh and Nguyen Van Kiem (2009), when fish are reared under favorable water environmental conditions with access to diverse and natural feed, their growth rate improves significantly. Conversely, growth can be slower when such conditions are unstable. In addition, the nutritional requirements of fish species also vary according to their feeding habits, developmental characteristics, physiological and ecological functions, and living conditions [22]. Duong Nhut Long et al. also noted that across many fish species, different developmental stages require higher nutritional demands (lipids, carbohydrates, and amino acids) presented in various feed types, to support efficient nutrient absorption, metabolism, growth, and overall development [23].

According to Pham Minh Thanh and Nguyen Van Kiem, when fish live in favorable environmental conditions and in water rich with diverse natural food sources, their growth rate occurs rapidly [9]. This is especially significant for many farmed fish species during the early stages of their life cycle, aiding in shaping and completing their body structure as well as physiological and ecological functions. Therefore, although a commercial pellet feed with a higher protein content (30%) still lacks certain essential amino acids required by fish, it plays an important nutritional role and has a positive impact on the growth of Onychostoma gerlachi, yielding higher efficiency compared to fish culture with a pellet feed containing 25% protein in this cultured model.

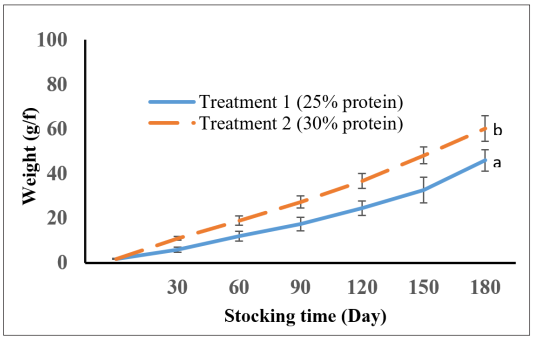

Figure 3: Growth of Onychostoma gerlachi in commercial culture systems

Survival Rate, Yield, And Feed Conversion Ratio of Onychostoma Gerlachi in Ponds

Survival Rate (%) of Commercially Farmed Onychostoma Gerlachi

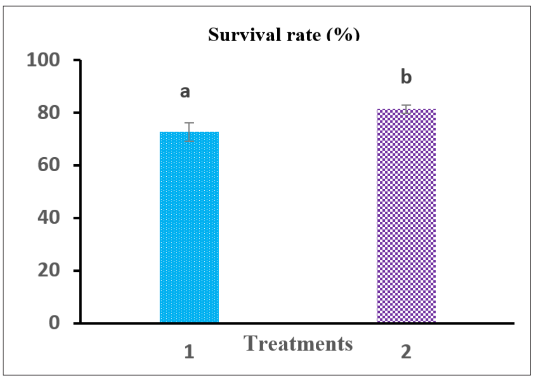

Figure 4: Survival rate (%) of Onychostoma gerlachi culture in culture ponds

After 6 months of culture, the survival rate of fish cultured in two treatments with different pellet feed protein of 25% and 30% protein (Figure 4) shown that fish in treatment 1 (25% protein feed) achieved an average survival rate of 73.7 ± 5.9%, lower than that of fish in treatment 2 (30% protein feed), which reached an average survival rate of 81 ± 2% ($P < 0.05$).

This value is lower than the survival rate (%) of high-quality fingerlings of Trichogaster pectoralis reared with commercial feed (35% protein), which ranged from 79.3–88.7% (Duong Nhut Long et al., 2018). The study has demonstrated that, in addition to yielding a relatively good-sized fish at harvest, commercial feed with a relatively high protein content (30%) plays an important role in stimulating feed intake, promoting nutrient absorption and metabolism, and thereby increasing both individual fish weight, survival rate, and overall productivity. As a result, the survival rate of 73.7–81% achieved for Onychostoma gerlachi is relatively high when compared to that of fish (Trichopodus pectoralis) from 80.9 – 89.8%; climbing perch (60 – 80%) and other species [24,25]. This provides important technical data that have significantly influences the productivity and efficiency of the Onychostoma gerlachi farming model.

Fish Yield (kg/ha)

After 6 months of culture, all of fish were harvested, and the results, as presented in Table 4, show that in treatment 1, the survival rate was 73.7%, yielding an average productivity of 3,367 ± 215 kg/ha. This was lower than in treatment 2 (30% protein), which achieved a survival rate of 81% and an average yield of 4,894 ± 558 kg/ha ($P < 0.05$). The yields of Onychostoma gerlachi cultured in ponds ranged from 0.34 – 0.49 kg/m².

Table 4: Survival rate (%) and yield (kg/ha) in culture ponds

Treatments	Technical parameters				
	Initial W (g/f)	End of W (g/f)	Survival rate (%)	Yield (kg/ha)	FCR
1	1,7 ± 0,2	46 ± 6,3[a]	73,7 ± 3,5[a]	3.367 ± 215[a]	2,4 ± 0,1[b]
2	1,7 ± 0,2	60,3 ± 5,7[b]	81,3 ± 1,5[b]	4.894 ± 558[b]	2,2 ± 0,2[a]

Note: Values are presented as mean ± standard deviation. Means within the same column followed by the same letter are not significantly different ($p > 0.05$)

According to Duong Nhut Long et al, the productivity of many farmed fish species in culture models depends greatly on factors such as water environment, quality of the seed, stocking density, feed quality, suitable care and management [23]. Therefore, the higher productivity observed in treatment 2 (30% protein feed) compared to treatment 1 (25% protein) is a natural result of the differing levels of protein absorption and metabolism within the culture farming system. Analysis of the experimental results also shows that the efficiency of the farming model is closely linked to the fluctuations in FCR values, which were 2.4 ± 0.1 of treatment 1 and 2.2 ± 0.2 of treatment 2. Under conditions where pellet prices fluctuate significantly, this information needs to be calculated and evaluated in terms of financial efficiency. This can serve as a basis for making recommendations so that farmers could apply these practices more effectively in production [26].

Conclusions

- The use of HCG alone as a hormonal stimulated for Onychostoma gerlachi at dosage levels ranging from 1,500 – 3,000 IU per kg of female did not induce egg maturation and ovulation. In spawning experiments, using stimulant (LHRHa + Domperidone) at a dosage of 100 µg + 10 mg Dom per kg of female, the results obtained successful egg maturation and ovulation, with a fertilization rate of 82.6 ± 3.4%, hatching rate of 77.1 ± 3.6%, and fecundity of 50,312 ± 18,392 eggs per kg of female fish.
- In nursing experiments, fingerlings in treatment with density of 1,000 fish/m² achieved growth of 1.8 ± 0.24 g per fish and a survival rate of 21.6 ± 2.5%, to bring benefits better results compared with fingerlings in treatment with a density of 1,500 fish/m², which resulted growth of 1.1 ± 0.3 g per fingerlings and a survival rate of 11.3 ± 2.7%.
- In the commercial grow-out experiments, fish fed a formulated pellet feed containing 30% protein exhibited higher growth (60.3 ± 5.7 g/fish), survival (81.0 ± 2.0%), and yield (4,894 ± 558 kg/ha ($P < 0.05$) compared with those fed a 25% protein feed, which resulted in a lower average weight (46 ± 6.3 g/fish), survival (73.7 ± 5.9%), and yield (3,367 ± 215 kg/ha).

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