THE RESULTS OF CULTURE SNUB-NOSE POMPANO (*Trachinotus blochii* Lacépède, 1801) IN THE "IN POND RACEWAY SYSTEM" IN KHANH HOA PROVINCE

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ARTICLE INFORMATION

Journal: *Vinh University Journal of Science Natural Science, Engineering and Technology*
p-ISSN*: 3030-4563*
e-ISSN: *3030-4180*

Volume: 54
Issue: 1A
Correspondence:
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Received: *22 November 2024*
Accepted: *17 February 2025*
Published: *20 March 2025*

Citation:
Nguyen Van Ha, Chu Chi Thiet, Nguyen Thanh Dung, Nguyen Thi Huong Thao, Tran Trong Tan, Nguyen Van Dang, Nguyen Tan Bao (2025). The results of culture snub-nose pompano (Trachinotus blochii Lacépède, 1801) in the "in Pond Raceway System" in Khanh Hoa province. ***Vinh Uni. J. Sci.*** *Vol. 54 (1A), pp. 98-106*
doi: 10.56824/vujs.2024a128a

ABSTRACT

The study aims to evaluate the environmental parameters and growth rate of snu-bnose pompano cultured in the "In Pond Raceway System - IPRS". Fingerlings 5-6 cm in length were stocked at a density of 72 fish/m^3 of 220 m^3 raceway (22 m length x 5 m width x 2 m depth) and placed in a 10,500 m^2 pond (125 m in length x 84 m in width) and 2.5 m depth. Fish fed by commercial pellet food (slow sinking food) contented 45-48% of protein at 7 am (30-40%) and at 4 pm (60-70%) with the feeding rate of 5-7% per day for small fish and 2-5% per day for a bigger size. After 7 months of culture, the fish achieved an average weight of 753 g. The absolute growth rate (in weight) reached 3.4 g per day, the specific growth rate (in length) 0.1 cm per day and the survival rate of 96.6%, and the total biomass reached 11,574 kg, equivalent to the productivity of 52.6 kg/m^3. This is an important step in the research and implementation of advanced technology in Khanh Hoa province and coastal culture areas to improve production and productivity per unit of water surface area.

Keywords: Snub-nose pompano; In Pond Raceway System; IPRS; environmental parameters; growth.

1. Introduction

Khanh Hoa province has many advantages in developing a marine culture with a coastline of 385 km and 200 islands and many lagoons and bays such as Van Phong Bay, Cam Ranh, Nha Trang and Nha Phu Lagoon. Marine fish farming in Khanh Hoa is currently developing in two farming systems: in the pond (612 hectares) and marine cage (10,394 cages), with a total output of 9,494 tons (of which pond farming has 1,894 tons) [1].

The Pond Raceway System (IPRS) was developed by Dr. Jesse Chappell, USA (2008). Based on the technology, fish cultured in the raceway gridlines only (occupying 2.2% of the pond volume), the remaining water areas (outside the raceways) in the pond have the function of

naturally processing and cleaning waste and leftover food before harvesting and returning to the raceway system [2]. Each raceway in the IPRS system has a volume of 220 m^3 (22 m length x 5 m width x 2 m depth). The White-Water Unit (WWU) installed at the top of the raceways supplies dissolved oxygen (6-8 mg/l) and creates a continuous flow. The fecal suction system is located in a quiet zone (QZ) (6 m length, 5 m width, 2.0 m depth), where solid waste, feces, and excess food are deposited when the flow slows down, thereby minimizing at least 70% of waste will be collected and taken out of the culture system [3]. The cultured fish fed at the top of the raceways. The excreta, solid waste and excess feed gradually settle to the bottom and are carried by the water flow to the end of the raceway and into the QZ area to be sucked out of the farming system by the pumping system. The flow allows water to circulate in the pond, limiting the water supply from the outside, thus controlling the spread of diseases and biosecurity. The IPRS system has advantages such as high stocking density, easy-to-control feeding, grading, and disease treatment, reduced labour and limited adverse environmental impacts [4].

The IPRS technology has been applied in many countries around the world, such as in China (in 2015) with the grass carp farming model, in Mexico and India (in 2017) with the tilapia farming model, in Pakistan (in 2018) with the red tilapia farming model and most recently the tilapia farming model in Thailand (in 2019) [3].

In Vietnam in 2016, the IPRS technology started to apply in the Norther in growing freshwater fish species: grass carp, tilapia, red tilapia… In 2019, Ngo Van Manh and his colleagues reared small fingerling seabass (18 mm length) in floating raceways at a density of 5-20 fish/L and bigger fingerlings (61.2mm) at a density of 5, 10, and 15 fish/L. There were positive results, but there have been no commercial culture trials yet [5].

Snub-nose pompano is a promising new marine culture species in Vietnam because it has high economic value and substantial domestic and foreign market demand. Therefore, recently, snub-nose pompano have been cultured in different systems like sea cages or coastal brackish saltwater ponds in coastal provinces such as Quang Ninh, Hai Phong, Khanh Hoa, and Vung Tau province. This commercial fish has a broad domestic and export market to Asian and American countries [6]. The Research Institute for Aquaculture No I (RIA I) has also cultured this species in sea cages at an industrial scale in Van Phong bays from 2013 up to now, with yearly output reaching from 250 to 300 tons [7].

This was the first time the IPRS technology had been applied to saltwater culture on a commercial scale in Vietnam. Applying IPRS technology in Khanh Hoa is feasible and consistent with development trends because the technology demonstrates environmental friendliness in the context of climate change, helping aquaculture sustainable development, increasing the survival rate of farmed fish, reducing labour costs for pond renovation, fish care, and harvesting, then decreased production costs.

2. Material & method

2.1. Time and location of research

The experiment was carried out at Xuan My village, Ninh Tho commune, Ninh Hoa district, Khanh Hoa province, belonging to Ngoc Thuy Service, Production, Trading Company Limited (Ngoc Thuy Company) from February 2024 to October 2024.

2.2. Materials

- *Research material*: Snub-nose pompano fingerlings 5-6 cm long, produced at Ngoc Thuy Company.

- *Experimental system*: The IPRS system has components of one 10,500 m^2 pond (125 m length x 84 m width) and 2.5 m depth, which constructed two raceways with 220 m^3 each (5 m width x 22 m length x 2 m depth).

Figure 1: *Complete the IPRS (Photo taken by Nguyen Van Ha, 2022)*

2.3. Research method

There were 15,797 (average 60.1 g and 9.7 cm length) snub-nosed pompano fingerlings cultured in a raceway set up in a 20,000 m^3 pond (according to the recommendation of USSEC) with a stocking density of 72 fish/m^3. The fingerlings were nursed in a concrete tank for a month and then transferred to the raceway until harvesting. During the nursing phase, fish were fed by slow sinking pellet food containing a 45-48% protein level at 7-8 am (30-40%) and 3-4 pm (60-70%). The experiment lasted 8 months until fish reached market size (average 0.7 kg each). The experiment fish fed by commercial food with a feeding rate of 5-7% body weight per day for their small size (5-6 cm length) and 2-5% for the bigger size. The water in the pond was exchanged about 30-50% volume when the turbidity was lower than 50 cm, and the environmental factors were changed to damage the fish. New water was pumped from the settlement pond. The water pH level was maintained in the range of 8-8.5 by lime at a dose of 1-2 kg/100 m^3. Leftover food and fecal waste in the IPRS system during the culture period were sucked into the tank by the automatic pumping system located at the end of the IPRS.

During the experiment period, fish were fed enough nutrients. They added vitamins and minerals to the food to increase the fish's resistance and maintained the appropriate environmental factors in the system. If the culture system infected the parasite, close the barrier at both ends of the raceway; it was very easy to handle and bathe the fish. Fish cultured were periodically checked (monthly) with a microscope at the Department of Aquatic Biotechnology and Vaccine, Research Institute for Aquaculture No.3. Fish were bathed in fresh water to remove the parasite (if infected) from the fish.

2.4. Data collection and analysis

- Collection of environmental parameters: The mercury thermometer measured Water temperature twice daily (8 am and 2 pm). The refractometer measured salinity; the oxygen meter checked pH and dissolved oxygen level (LT Lution DO-5511, Taiwan). Alkalinity, NH_3, NO2-, and NO_3- were measured by Sera Test (Germany). Turbidity was checked by Secchi disc, and the flow rate of water in raceways was checked by the vertical float tube (according to USSEC instructions).

- The growth rate and survival rate of experimental fish were periodically checked (30 samples) every 15 days in weight (W) and length (L). The electronic scale weighed the weight of the fish with an accuracy of 0.1g and the length measured by the ruler (accuracy of 0.1 mm). The indicators of the experiment were determined by formulation following:

+ Absolute growth rate in weight: AGR_W (g/fish) = $\frac{W_2-W_1}{t_2-t_1}$

+ Specific growth rate in weight: SGR_w (%/day) = $\frac{L_nW_2-L_nW_1}{t_2-t_1} \times 100$

+ Absolute growth rate in length: AGR_L (cm/fish) = $\frac{L-L_0}{t-t_0}$

+ Specific growth rate in length: SGR_L (%/day) = $\frac{L_nL_2-L_nL_1}{t_2-t_1} \times 100$

+ Food coefficient ratio: $FCR = \frac{P_{cc}}{P_{tt}}$

+ Survival rate: $SR\ (\%) = \frac{T_2}{T_1} \times 100$

+ Coefficient of variation (%): $CV_{L,W}$ (%) = $\frac{S}{\bar{X}} \times 100$

In which: W_1, W_2 corresponding the weight of fish at time t_1, t_2; L_1, L_2: length of fish at time t_1, t_2, respectively; P_{cc}: the total utilized food (kg); P_{tt}: the gained weight of fish (kg); T_1, T_2: the initial number and the final number of fish stocked in the experiment, S: standard deviation of weight and length, and $\bar{X}$: average of weight and length.

- Data analysis: The experimental data were analyzed by Excel 2016 software to determine the average values and standard deviations of the samples

3. Result and discussion

3.1. Environmental parameters during the culture period

Environmental parameters during the experimental period of snub-nose pompano cultured in the IPRS are shown in Table 1.

Table 1 shows that the snub-nose pompano culture environment was relatively stable; all parameters were monitored in between the appropriate range for fish growth. The dissolved oxygen level in the water in the culture period was stable, ranging from 5.0-6.8 mg/L. The achievement resulted in the research team refining the white-water unit by increasing the nanotubes that created air bubbles in the water pond system and regularly checking the oxygen level every 0-3 am. When the dissolved oxygen level dropped, the pander wheel systems were run in front of and behind the raceways. According to Ngo (2015), the appropriate temperature for the growth and survival rate of snub-nose pompano

from 18 to 30ºC [8]; and Cheng (1990), snub-nose pompano typically grow at temperature ranges from 16 to 36^{0}C, and the best growth rate temperature range of 22-28ºC [9]. From the third month of culture, the operation of the manure collection machine increased from 4 times per day to 8 times per day to minimize waste created in the raceways and IPRS.

Table 1: *Environmental parameters recorded at the culture system*

Parameters/unit	Time	Value
Temperature (^{0}C)	8 am	$\frac{26 - 34}{30.0 \pm 1.8}$
	2 pm	$\frac{27.0 - 35.5}{32.0 \pm 1.9}$
DO (mg/L)	8 am	$\frac{5.1 - 6.8}{6.3 \pm 0.5}$
	0 am	$\frac{5.0 - 5.4}{5.1 \pm 0.1}$
pH	8 am	7.5-8.0
	2 pm	7.8-8.5
Salinity (‰)	8 am	$\frac{34 - 36}{35.3 \pm 0.5}$
NH_3 (mg/L)	8 am	$\frac{0.00 - 0.08}{0.04 \pm 0.01}$
NO_2 (mg/L)	8 am	$0 - 2$
NO_3 (mg/L)	8 am	$\frac{10 - 50}{34.2 \pm 15.9}$
Alkalinity (mg/L)	8 am	$89.5 - 143.2$
Turbidity (cm)	8 am	$\frac{24 - 50}{34.6 \pm 5.5}$

Notes: *The table shows the average mean ± standard deviation (Mean ± SD)*

3.2. Growth of snub-nose pompano cultured in the IPRS

Table 2: *Whole body weight, growth rate in weight, and coefficient of variation of snub-pompano cultured in IPRS*

Month of culture	BW (g)	Gained weight (g)	AGR$_W$ (g/day)	SGR$_W$ (%/day)	CV (%)
Initial	60.0 ± 1.6	45.0			
1	105.1 ± 2.1	44.9	1.5	1.86	2.01
2	150.0 ± 8.4	118.6	1.5	1.19	5.60
3	268.6 ± 45.6	138.1	4.0	1.90	17.00
4	406.7 ± 33.0	130.0	4.6	1.40	8.10
5	536.7 ± 25.1	147.3	4.3	0.90	11.00

Month of culture	BW (g)	Gained weight (g)	AGR_W (g/day)	SGR_W (%/day)	CV (%)
6	684.0 ± 72.1	69.0	4.3	0.70	10.50
7	753.0 ± 82.6	45.0	2.3	0.30	11.00
Average			**3.3**	**0.90**	**8.70**

Notes: *The date in the table shows the average mean ± standard deviation (Mean ± SD). BW: Body weight of fish; AGR_W: Absolute growth rate in weight; SGR_W: Specific growth rate in weight; CV (%): Coefficient of variation*

Table 2 shows that fish reached 753 g (gained 693 g) after seven months of culture meeting the market size. The average absolute growth rate (AGR g/day) of fish in the culture period ranged from 3.3 g per day, with slower growth in the first 2 months of culture and faster growth in the next third month to the sixth month, but it was slowed down at the end of the culture period. The experiment fish had an average specific growth rate (SGR %/day) of 0.9% g per day, ranging from 0.3-1.9% g per day, higher in the initial experiment period (the second to the fourth month of culture). They had a slow downtrend from the fifth to the end of the cultural period. The coefficient variation (CV%) averaged 8.7%, between 2.01 and 17.00%. The result indicates that the CV is higher in the bigger size of fish.

The above observation is the first result of culture snub-pompano in the IPRS; there are no accurate growth rate data for comparison. However, the result can be compared to the marine cage culture. Nguyen (2014) studied culture snub-nose pompano (6-8 cm length) in the pond at three fish per m^2 density. After 9 months of culture, the average fish size at harvesting was 511 g per fish, the absolute growth rate in weight reached 2.4 g per day, and the specific growth rate in weight reached 0.03% per day [10]. Pham (2022) cultured pompano (average weight of 73 g) in cages at sea at the density of 8, 9 and 10 fish per m^3; after 6 months of culture, the average harvested size of culture fish ranged from 471-608 g, the specific growth rate in weight of fish were ranged of 1.03-1.17% per day [7].

Table 3: *Total length, growth rate in length, and coefficient variation of snub-nose pompano cultured in IPRS*

Month of culture	TL (cm/fish)	AGR_L (cm/day)	SGR_L (%/day)	CV (%)
Initial	9.7 ± 0.3			
1	13.9 ± 0.4	0.14	1.20	2.62
2	18.1 ± 0.2	0.14	0.88	2.68
3	21.5 ± 1.0	0.10	0.60	4.80
4	24.1 ± 1.4	0.10	0.40	6.00
5	25.1 ± 1.8	0.03	0.10	7.30
6	26.2 ± 1.2	0.03	0.10	4.40
7	**29.5 ± 1.5**	**0.10**	**0.40**	**5.00**
Average		**0.10**	**0.40**	**4.70**

Notes: *The table shows the average mean ± standard deviation (Mean ±SD). TL: Total length of fish; AGR_L: Absolute growth rate in length; SGR_L: Specific growth rate in length; CV (%): Coefficient of variation*

The total length of snub-nose pompano cultured in the IPRS increased from 9.7 cm at the experiment's initial to 29.5 cm at the harvesting time. Culture fish had a higher growth rate in the first four months than two months toward the end of the culture period. According to Nguyen (2014), the snub-nose pompano achieved an average length of 31 cm when cultured in the earth ponds for 9 months, an absolute growth rate length of 0.11 cm per day, a specific growth rate length of 0.015% per day [10]. These results were equivalent to the growth rate of snub-nose pompano performed in this experiment.

3.3. Survival rate, FCR and production

Table 4: *The survival rate, feed conversion ratio and productivity of fish cultured in the IPRS*

Contents	Valuation
SR (%)	96.6
FCR	2.02
Productivity per pond (ton/ha)	11.574
Productivity per raceway (kg/m3)	52.6

The survival rate of the snub-nose pompano cultured in the IPRS was relatively high (96.6%), and the feed conversion ratio (FCR) was 2.02. The productivity calculated by raceway reached 52.6 kg/m^3, higher compared to the recommended by the US Soybean Export Association (40 kg/m^3). Pham (2022) cultured pompano in marine cages had an FCR of around 1.84-2.63 and a survival rate of 89-94% [7].

Snub-nose pompano cultured in the IPRS was proactive in harvesting with different product amounts and quickly. On the other hand, fish grown in the pond raceway system were strictly controlled for disease prevention and treatment. Timely detection and early treatment of diseases were carried out very effectively and promptly by closing both ends of the culture raceway with plastic tarpaulin and turning off the white water unit, then running an aeration system on both sides of the raceway's wall to bathe the fish. This is a highly superior feature that the traditional cultural systems could not achieve. However, the investment cost was high for a module to operate according to the design, requiring a large enough area to set up as the regulation of 10,000 m^3 for a raceway.

Meanwhile, households in most traditional cultures often take advantage of inefficient ponds and available areas. The salty environmental conditions quickly corrode metal, so equipment must be regularly maintained and use more expensive materials than in freshwater environments. Due to the high stocking density of culture, highly qualified personnel are required to operate synchronous machinery and equipment and complete backup.

4. Conclusion

The snub-nose pompano cultured in the IPRS in Khanh Hoa province had a fast growth rate and high survival rate. The initial result indicated that after seven months of the culture period, the fish had an average harvest size of 753 g, total production of 11,574 kg, survival achieved 96.6%, and FCR was 2.02. The productivity by the pond achieved 11,574 tons per ha, and the productivity by the raceway was 52.6 kg per m^3.

It is necessary to continue to have experimental farming models on other marine fish species in the coming time to supplement data for the results and find the optimal farming species in the future.

Acknowledgement: The article is part of the results of a science and technology research project at the Khanh Hoa provincial level: "Application of " In Pond Raceway System" technology to culture marine fish in Khanh Hoa" by MSc. Nguyen Van Ha and Engineer Nguyen Thi Huong Thao were co-chairs, contract number 387/HD-KHCN dated April 4, 2022. The authors would like to express their deep gratitude to the People's Committee of Khanh Hoa province, Khanh Hoa Department of Science and Technology, Khanh Hoa Agricultural Extension Center and Ngoc Thuy Services, Production and Trading Company Limited for creating conditions of funding, time, and facilities to complete this research.

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TÓM TẮT

MỘT SỐ KẾT QUẢ NUÔI CÁ CHIM VÂY VÀNG (*Trachinotus blochii* Lacépède, 1801) THƯƠNG PHẨM TRONG HỆ THỐNG "SÔNG TRONG AO" TẠI KHÁNH HÒA

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Ngày nhận bài 22/11/2024, ngày nhận đăng 17/02/2025

Nghiên cứu nhằm đánh giá các chỉ số môi trường và sinh trưởng của cá chim vây vàng nuôi trong hệ thống "sông trong ao". Cá chim vây vàng giống có kích cỡ 5-6 cm, đồng đều, mật độ 72 con/m^3, máng nuôi thể tích 220 m^3 (22 m x 5 m x 2 m) đặt trong ao diện tích 10.500 m^2 (125 m x 84 m), độ sâu 2,5 m. Thức ăn công nghiệp dạng viên chìm chậm với hàm lượng đạm từ 45-48%, cho ăn vào 7h (30%-40%) và 16h (60-70%), giai đoạn cá nhỏ ăn 5-7%, giai đoạn cá lớn ăn 2-5% trọng lượng cơ thể. Sau 7 tháng, cá chim vây vàng thương phẩm nuôi trong hệ thống sông trong ao đạt tỷ lệ sống 96,6%; kích cỡ trung bình 753 g/con, tốc độ tăng trưởng về khối lượng đạt 3,4 g/ngày, tốc độ tăng trưởng về chiều dài đạt 0,1 cm/ngày. Sản lượng thu hoạch đạt 11.574 kg, trung bình đạt 52,6 kg/m3. Đây là bước tiên phong cho quá trình nghiên cứu nhân rộng mô hình thực hiện tại địa phương cũng như những vùng nuôi ven biển nhằm nâng cao năng suất và sản lượng trên một đơn vị diện tích mặt nước.

Từ khóa: Cá chim vây vàng; hệ thống "sông trong ao"; IPRS; thông số môi trường; tăng trưởng.