



Research article

Optimizing growth and production efficiency of snakeskin gourami (*Trichopodus pectoralis*) through intensive cage culture: Impacts of culturing season and sex

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Abstract

Importance of the work: The influence of season initiation and sex on the intensive cage culture of snakeskin gourami has largely been unexplored. This study aims to address this gap by examining how these factors affected body weight at harvest.

Objectives: To assess the effects of culturing season initiation and sex on the body weight of snakeskin gourami reared in intensive cage culture.

Materials and Methods: Data were collected from 941 specimens across eight production batches harvested between 27 November 2021 and 4 September 2022. Analysis of variance and multiple comparisons were conducted to determine the influence of sex, culturing season initiation and culturing period on body weight at harvest.

Results: The average initial body weight ranged from 8.21 to 23.30 g, with a survival rate of 93.02%. The mean body weight ($\pm$ SD) in males (162.95 ± 2.53 g) was significantly ($p < 0.001$) smaller than in females (208.15 ± 1.85 g). Fish cultured in summer had significantly ($p < 0.001$) higher body weights (200.43 ± 3.04 g) compared to those in the rainy (179.05 ± 3.27 g) or winter (177.18 ± 2.05 g) seasons. Total yields ranged from 932.5 kg to 1,081 kg, with costs in the range USD 1.11–1.21/kg. Winter had the highest profit (USD 0.93/kg), followed by summer (USD 0.92/kg), while the rainy season had the lowest profit (USD 0.67/kg), with no significant differences between the rainy and winter seasons.

Main finding: Snakeskin gourami, with larger females, adapted well to intensive cage culture. Culturing in the summer yielded optimal growth, offering a strategic advantage for maximizing production efficiency. Farmers should plan cycles to prioritize summer culturing and understand sex-based growth differences.

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Introduction

Trichopodus pectoralis, commonly known as the snakeskin or Siamese gourami, has major economic importance in Southeast Asia, particularly in Thailand, Vietnam, Malaysia and Indonesia, due to its exceptional taste and flavor profile that command premium prices (Indrambarya, 1980). Known as “Pla Salid” in Thailand and “Sepat Siam” in Malaysia and Indonesia, this species has historically been cultivated in marshlands, swamps and rice fields (Yoonpundh and Little, 1997; Vromant et al., 2001). While previously raised in extensive ponds, there has been a recent shift, with a limited portion of snakeskin gourami production transitioning to cage culture (Department of Fisheries, 2022).

The snakeskin gourami exhibits sexual dimorphism, with females typically displaying a notable size advantage over males (Chatchaipphan et al., 2019; Boonanuntanasarn et al., 2020). Male individuals are characterized by their darker coloration, slender shape and sharper dorsal fin (Pongthana et al., 1999). Given that snakeskin gourami is typically marketed upon sexual maturation, this size dimorphism has important economic implications. Additionally, the species displays sexual plasticity, influenced by genetic and environmental factors, although the exact sex-determination system remains cryptic (Boonanuntanasarn et al., 2020; Panthum et al., 2021).

While cage culture in rivers and lakes has been extensively studied and implemented for various fish species, such as black-chinned tilapia (*Sarotherodon melanotheron*, (Ouattara et al., 2003), tambaqui (*Colossoma macropomum*, (Gomes et al., 2006) and Nile tilapia (*Oreochromis niloticus*, Ofori et al., 2010), limited attention has been given to the intensive cage culture of snakeskin gourami, especially in river environments. Despite some efforts in this direction, such as nursing juvenile fish in cages fixed in earthen ponds and rearing the grow-out phase, there is a major gap in the literature regarding intensive cage culture, particularly in river

environments (Leknoi and Chantaganond, 2013; Chatchaipphan et al., 2019).

In tropical regions, such as Thailand, temperature and photoperiod significantly influence the physiological processes and reproductive biology of fish (Hails and Abdullah, 1982). In particular, temperature plays a critical role in modulating immune responses, metabolic rate and oxygen consumption, all of which are pivotal for the growth and survival of aquatic species (Abram et al., 2017). Elevated temperatures beyond thermal thresholds can disrupt metabolic processes, reduce feed intake and compromise immune function, thereby affecting fish growth and production efficiency (Mugwanya et al., 2022).

The current study was carried out within Thailand’s climatic framework, which includes distinct winter, summer and rainy seasons (Amatayakul and Chomtha, 2015) in the Mae Klong River. The aim was to elucidate the influence of initial culturing season, sex-specific responses, and culture duration on the body weight at harvest in intensive cage-cultured snakeskin gourami. In addition, this investigation was the first report on applying cage culture practices to snakeskin gourami in a reservoir setting, which has traditionally only been conducted in earthen ponds.

Material and Methods

Fish and culturing

Fish data were systematically collected from the Kaveewat farm located in the Mae Klong River, Khao Noi, Tha Muang, Kanchanaburi, Thailand (13°58’03”N, 99°35’16”E, elevation 23.12 m above mean sea level), covering the period from 25 November 2020 to 27 December 2021 (Table 1). Each production batch, consisting of 4,500 juvenile fish, each weighing 15–30 g, was obtained from the nearby nursery and was housed in a rectangular floating cage measuring 3 m × 5 m × 3 m, securely anchored in the Mae Klong River.

Table 1 Summary of culturing undertaken in study

Round	Starting season	Initial ABW (g)	Number of samples	Harvest body weight (g)	Survival rate (%)	Starting date	Harvesting date	Culturing period (d)
1	Winter	11.99	124	193.76 ± 42.34	94.36	25/11/2020	27/11/2021	368
2	Winter	10.00	154	135.42 ± 23.16	93.39	07/12/2020	27/11/2021	356
3	Winter	8.21	104	134.55 ± 25.49	93.97	27/12/2020	27/11/2021	336
4	Summer	13.00	100	185.10 ± 50.07	93.08	11/04/2021	01/04/2022	356
5	Summer	11.40	101	194.71 ± 43.78	94.08	24/04/2021	03/05/2022	375
6	Rainy	11.00	124	218.57 ± 43.12	90.81	05/07/2021	03/05/2022	367
7	Rainy	11.40	121	228.72 ± 48.60	92.21	23/08/2021	06/07/2022	378
8	Winter	23.30	113	229.87 ± 53.08	92.29	27/12/2021	04/09/2022	374

ABW = Average body weight.
Values are presented as mean ± SD.

These cages were constructed using typical 15 mm multifilament stretch mesh netting sourced from a local seine fishery and they were attached to a pipe framework supported by floating plastic barrels anchored at a depth of 5 m.

The culture periods spanned from 336 d to 378 d, during which all fish were provided with a uniform diet consisting of 30% crude protein pellet feed formulated explicitly for snakeskin gourami (Betagro 811; Betagro Co., Ltd; Lopburi, Thailand), administered three times daily. Feed quantities were adjusted based on the average body weight of the fish, initially set at 10% of their body weight and gradually reduced to 2% upon reaching the desired harvest size. This standardized feeding regimen aimed to ensure optimal growth and development of the snakeskin gourami throughout the culture period, thereby contributing to the study's objectives of analyzing factors influencing body weight in intensive cage-cultured snakeskin gourami.

Data collection

Data collection procedures were rigorously conducted in collaboration with the farm proprietor and local fish collectors to ensure accurate and comprehensive documentation of relevant information. Upon reaching the target fish harvest size of approximately 180 g, harvest dates were arranged by consultation between the farm proprietor and local fish collectors. Data collection occurred throughout the harvesting period, during which detailed records were maintained for a total of 941 specimens from eight batches (Table 1). A single scoop net was used to select specimens from each batch randomly.

The average initial body weight data for each batch were derived from operational records. During the study, individual body weights of harvested fish were meticulously recorded by the farm owner prior to transferring the catch to the fish collector. Sex determination relied on visual inspection of external morphological features, with males identified by their pointed and elongated dorsal fin tips extending to the caudal peduncle and the presence of tubercles on the caudal peduncle. Females were identified by their shorter and rounder dorsal fin tips, which were consistent with criteria from other studies (Chatchaiphon et al., 2019; Boonanuntanasarn et al., 2020). The sex ratio of fish stocked before placing them in floating cages was not estimated due to their small size and the lack of visible sexual dimorphism. However, it was assumed to be approximately equal (1:1).

The seasonal variations in climate were based on the categorization by the Thai Meteorological Department under the Ministry of Digital Economy and Society. The year was divided into three distinct seasons: winter, spanning from mid-October

to mid-February; summer, from mid-February to mid-May; and the rainy season, commencing from mid-May and lasting until mid-October (Amatayakul and Chomtha, 2015). These seasonal distinctions provided a contextual framework for analyzing the influence of the season when culturing commenced on the body weight at harvest in intensive cage-cultured snakeskin gourami, as outlined in the research objectives.

The economic analysis in this study evaluated the financial performance of intensive cage culture for snakeskin gourami across varying seasons. Data on total yields and costs were converted to US dollars (USD 1 = THB 36.27), including feed, medication and fingerling expenses and were collected from eight production batches from 27 November 2021 to 4 September 2022. The costs per kilogram of harvested fish and profitability metrics were calculated to assess the economic dynamics of each season—winter, summer and rainy.

Statistical analyses

Statistical analyses were conducted to ensure a robust interpretation of the harvested body weight data. The initial study assessed the data distribution using normality tests supplemented by graphical representations such as density plots. Descriptive statistics were then applied to summarize the trait being investigated. The influence of various factors on body weight at harvest, costs and profitability among seasons was examined using an analysis of variance followed by Bonferroni post hoc testing for multiple comparisons. This analytical approach allowed for the examination of factors such as sex, initiation seasons, and culture duration, based on Equation 1:

$$y_{ijk} = \mu + b(CP) + Sex_i + Season_j + e_{ijk} \quad (1)$$

where y_{ijk} is the individual phenotypic body weight value, μ is the overall population mean body weight, $b(CP)$ is the effect of the days of the culturing period, Sex_i is the effect of individual sex distinguishing on body weight (i = male and female); $Season_j$ is the effect of the initiation season of culturing (j = winter, summer and rainy) and e_{ijk} is the residual error of the animals (k), which accounts for unexplained variances in body weight beyond the variables included in the model.

A significance threshold of $p < 0.05$ was applied to identify statistically significant differences. Least square means (LSMEANS) with the SE were calculated to interpret the variables. This approach aimed to provide a clear understanding of the impact of different factors on body weight in intensive cage-cultured snakeskin gourami. Results were presented as mean $\pm$ SD values.

Results

Growth performance and survival rates

The initial body weight of the snakeskin gourami in intensive cage culture was in the range 8.21–23.30 g (Table 1). The overall survival rate during the grow-out phase was 93.02%. Season-specific survival rates were slightly higher for winter (93.50%, SD = 0.90) and summer (93.58%, SD = 0.71) compared to the rainy season (91.51%, SD = 0.99), as shown in Table 2. These very similar values with low standard deviations indicated stable survival rates across the different seasons, demonstrating the resilience of the species under varying environmental conditions.

Influences on final body weight

The average harvest body weight was 188.91 g (SD = 55.40 g). Significant factors influencing final body weight were the culturing period (336 d to 378 d; $F = 217.44$, $p < 0.001$), initiation season ($F = 22.03$, $p < 0.001$) and sex ($F = 225.21$, $p < 0.001$).

Sex-based growth differences

In total, 346 male and 595 female snakeskin gourami were harvested. Female body weights were in the range 76.00–401.00 g, while for males, the range was 83.00–305.80 g (Fig. 1). Thus, the females were generally heavier, with an LSMEAN $\pm$ SE for females being 208.15 ± 1.85 g compared to 162.95 ± 2.53 g for males. This significant difference highlighted the necessity to consider sex in the growth performance analysis for intensive cage culture systems.

Seasonal variability in body weight

Body weights at harvest varied with the initial season of cultivation (Fig. 2). In summer, body weights were in the range 83.00–401.00 g, in the rainy season they were in the range 113.00–324.90 g and in winter they were in the range 76.00–339.80 g. The LSMEAN $\pm$ SE value for summer (200.43 ± 3.04 g) was significantly ($p < 0.001$) higher than for the rainy (179.05 ± 3.27 g) and winter (177.18 ± 2.05 g) seasons (Fig. 4).

There was no significant difference between the rainy and winter seasons. These findings suggested that the timing of culture initiation significantly impacted growth performance, likely due to variations in temperature and water conditions.

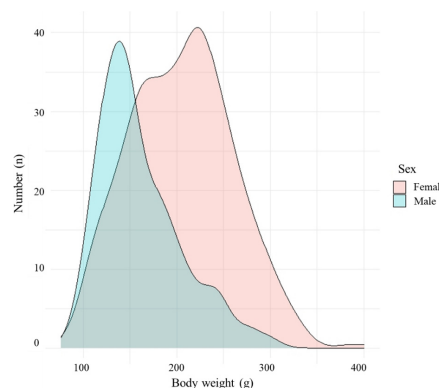


Fig. 1 Density graphs representing distributions of male ($n = 346$) and female ($n = 595$) body weight of snakeskin gourami at harvest

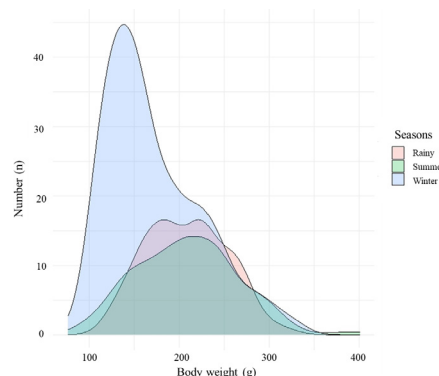


Fig. 2 Density graphs representing body weight distribution of snakeskin gourami at harvest according to season, where winter ($n = 503$), summer ($n = 213$) and rainy season ($n = 225$)

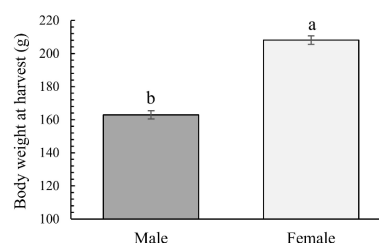


Fig. 3 Least square mean of body weight at harvest across seasons for male ($n = 346$) and female ($n = 595$) snakeskin gourami, where different lowercase letters indicate significant ($p < 0.001$) differences and error bars indicate $\pm$ SE.

Table 2 Economic analysis of snakeskin gourami in intensive cage culture across different seasons

Starting season	Survival rate (%)	Total yield (kg)	Total cost (USD)	Cost (USD)/kg	Profit (USD)/kg
Winter	93.50 $\pm$ 0.90	961.50 $\pm$ 106.18	1,287.71 $\pm$ 178.81	1.11 $\pm$ 0.33	0.93 $\pm$ 0.27
Summer	93.58 $\pm$ 0.71	1,081 $\pm$ 193.75	1,584.23 $\pm$ 127.16	1.15 $\pm$ 0.11	0.92 $\pm$ 0.30
Rainy	91.51 $\pm$ 0.99	932.5 $\pm$ 96.87	1,457.27 $\pm$ 47.73	1.21 $\pm$ 0.12	0.67 $\pm$ 0.15

Values are presented as mean $\pm$ SD.

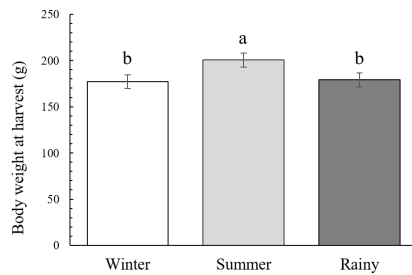


Fig. 4 Least square mean of body weight at harvest for three seasons for commencement of culturing (rainy, summer and winter) across sex of snakeskin gourami, where different lowercase letters indicate significant ($p < 0.001$) differences and error bars indicate $\pm$ SE.

Economic analysis

The economic analysis (Table 2, Fig. 5) revealed the following:

1) Winter season: Total yield averaged 961.50 ± 106.18 kg with a total cost of USD $1,287.71 \pm 178.81$. Feed costs constituted 80.93% (SD = 10.60) of the total, medication costs 4.09% (SD = 3.22) and fingerling costs 14.98% (SD = 12.25). The cost per kilogram averaged USD 1.11 ± 0.33 , with a profit per kilogram of USD 0.93 ± 0.27 .

2) Summer season: Total yield increased to $1,081 \pm 193.75$ kg with total costs of USD $1,584.23 \pm 127.16$. Feed costs were 80.87% (SD = 9.22), medication costs 3.04% (SD = 2.82) and fingerling costs 16.10% (SD = 12.04). The cost per kilogram was USD 1.15 ± 0.11 , with a profit of USD 0.92 ± 0.30 .

3) Rainy season: The yield was the lowest for this season at 932.5 ± 96.87 kg with total costs of USD $1,457.27 \pm 47.73$. Feed costs dropped to 74.22% (SD = 0.39) and medication costs to 0.87% (SD = 0.17), with fingerling costs increasing to 24.92% (SD = 0.54). The cost per kilogram was USD 1.21 ± 0.12 , with a profit per kilogram of USD 0.67 ± 0.15 .

This analysis highlighted that while summer had the highest yield and costs, the rainy season had the lowest yield and the highest cost per kilogram. Winter struck a balance with moderate yields and costs, with the highest profit per kilogram.

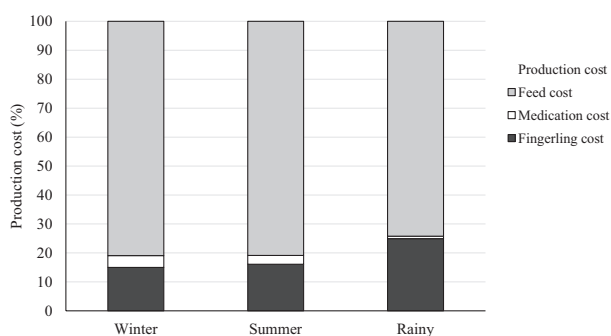


Fig. 5 Production cost of snakeskin gourami cultured by season

Discussion

Several key factors contributed to the success observed in the intensive cultivation of snakeskin gourami within floating cages on the Mae Klong River. The notably high survival rates during the grow-out phase surpassed those reported in other cultivation methods, especially exceeding those of cage-fixed pond culture (88.70–92.99%; Chatchaiphan et al., 2019) and large earthen pond culture (39.56–49.44%; Sampantarak et al., 2004). Using a bigger initial body weight of fingerling enhanced the survival rate, as has been reported for other fish species (Gupta and Haque, 2012; Wainaina et al., 2022). High survival rates of the snakeskin gourami were observed across different seasons, particularly in winter and summer. This trend contrasted with those for other freshwater fish reared in cage farming in reservoirs, where mortality was often caused by fluctuating temperatures, poor water quality, pollution, predation by birds and diseases (Baleta et al., 2019). Suwanpakdee et al. (2021) reported disease outbreaks among major fish species in cage culture during summer; however, snakeskin gourami demonstrated greater resistance, requiring fewer medications. This finding highlighted the inherent advantages of floating cage culture, presenting a strategic alternative to traditional pond-based methods.

Central to this success was the strategic selection of initial body weights in the range 8.21–23.30 g. This decision highlighted the judicious utilization of resources compared to pond-based culturing, where the same space is often dedicated to spawning activities. The stocking density of 300 fish/m² in intensive cage culture represents a substantial augmentation over reported densities in various other cultivation methods, including large earthen ponds (4–8 fish/m²; Sampantarak et al., 2004), intensive partition ponds (5–20 fish/m²; Sema, 1995) and cage-fixed ponds (10–30 fish/m²; Chatchaiphan et al., 2019). Furthermore, the extended culturing period spanning 336–378 days significantly contributed to the overall success, exerting a profound influence on the final body weight of the snakeskin gourami, which aligned with Chatchaiphan et al. (2019). The discernible sexual dimorphism observed, with females exhibiting markedly larger body weights compared to males, as reported by Boonanuntanasarn et al. (2020), accentuated the economic implications of comprehensively understanding and managing the growth rates of different sexes within intensive cage culture settings. These findings underscored the importance of optimizing both stocking density and culturing duration in intensive cage culture to maximize the growth and survival of snakeskin gourami, thereby providing invaluable insights for the aquaculture industry.

The initial size of fish fingerlings played a pivotal role in determining the culture duration and overall efficiency of aquaculture operations. Akbulut et al. (2002) highlighted that larger, higher-grade fingerlings required a longer culture period in rainbow trout, (*Oncorhynchus mykiss*) but yielded substantial benefits in terms of weight gain, specific growth rates and overall fish yields compared to smaller counterparts. Conversely, stocking smaller fingerlings shortened the culture period to about 35–150 d but resulted in lower productivity and economic returns (Network of Aquaculture Centres in Asia-Pacific, 1989). This was reinforced by the observation that larger fish could be described using the cube law, where weight increased proportionally to the cube of length, emphasizing the advantages of starting with larger fingerlings for enhanced growth and operational efficiency (Akbulut et al., 2002). Strategies, such as increasing feeding frequency, using high-quality feeds, regular grading, implementing partial harvesting and exploring polyculture systems, are recommended to optimize feeding regimes and achieve desired growth and yield objectives. These approaches not only promote efficient feed utilization and growth rates but also mitigate competition among fish, thereby maximizing overall pond productivity and economic returns (Network of Aquaculture Centres in Asia-Pacific, 1989; Akbulut et al., 2002; Kim et al., 2020).

The body weight of snakeskin gourami whose culture was initiated in summer significantly exceeded those starting in the rainy and winter seasons. However, no significant difference was observed between those whose culture commenced in the rainy and winter seasons. The average temperature, encompassing all seasons from 2021 to 2022, was 28.0°C, with winter registering 26.3°C, summer 29.7°C and the rainy season at 28.4°C (Thai Meteorological Department, 2024). Generally, fish are ectothermic, meaning their body temperature is influenced by the environment; thus, warmer temperatures can increase activity and higher feeding rates in many species (Mugwanya et al., 2022).

The optimal season for starting the culture of snakeskin gourami in cage culture requires a balanced consideration of yield, cost, and net profit metrics. The summer season produced the highest production, but also incurred the highest total cost. Despite the elevated costs, the cost per kilogram and the profit per kilogram in summer closely mirrored those of the winter season. Winter culturing produced a total yield and a lower total cost alongside the lowest cost per kilogram and profit per kilogram, making it economically feasible with balanced returns. In contrast, the rainy season, with the lowest yield and total cost, had the highest cost per kilogram and the lowest profit per kilogram, indicating less favorable economic viability.

Hails and Abdullah (1982) discovered that snakeskin gourami had two main peaks in reproductive activity annually—March

and September. Additionally, Vromant et al. (2001) proposed that the production of snakeskin gourami could decrease due to a restricted growing season. Typically, March fingerlings achieve a body weight of 15–30 g by May, making it an advantageous period for smaller-scale farming as it transitions from the late summer season to the early rainy season. Conversely, fingerlings hatched in September reached harvest size by November, making them suitable for growth during the winter season and potentially reducing the cost of acquiring fingerlings. This research highlighted the intricate relationship between the timing of initiation and subsequent seasons in cage farming.

Beginning the culture in winter offered several benefits, including yielding moderate outputs and maintaining costs under control, ultimately leading to high profitability per unit. The advantageous winter conditions facilitated stable production with manageable expenses for feeding, medications and fingerlings. However, winter may yield slightly lower results compared to summer, potentially restricting the overall revenue. Typically, warmer temperatures elevate metabolic activities, impacting growth rates, energy consumption and general health, as evidenced in other fish species (Lee et al., 2003; Volkoff and Rønnestad, 2020). On the other hand, summer had the highest production yield for snakeskin gourami, resulting in a substantial total output suitable for sales. Nonetheless, the primary downside of summer cultivation was its escalated overall expenses due to heightened costs for feed, medications and fingerlings, potentially affecting absolute profit margins. Conversely, the rainy season had the least cost-effectiveness, characterized by higher costs for feeding and fingerlings, alongside diminished profit per kilogram, indicating increased risks. Despite potentially favorable growth conditions during the rainy season, the economic challenges resulting in reduced overall profitability make this period less enticing for culture. Considering yield, cost-efficiency and profit margins, the winter season emerged as a balanced and potentially optimal time for culturing snakeskin gourami in cage culture by maximizing profit per kilogram with manageable production costs, despite slightly lower yields compared to the summer season.

This study underscored the imperative of implementing cage culture for snakeskin gourami in the Mae Klong River. Intensively confining snakeskin gourami was pivotal for year-round output optimization, ensuring maximal profits. While production typically peaked in winter, coinciding with the fish achieving peak quality by accumulating energy reserves as gonadal fat, this abundance can lead to a price decline. Prioritizing body weight at harvest, an easily measurable trait, is crucial, with observed sexual dimorphism—females being larger than males—bearing economic significance (Boonanuntanasarn et al., 2020).

This study emphasized the need for a comprehensive strategy, considering underexplored factors such as water quality parameters (water flow rate, turbidity, total nitrogen, pH, dissolved oxygen) and variations in water temperature. Critical investigations into the optimal water flow rate and dissolved oxygen levels are essential for determining the best stocking density in river cage culture. Specifically, water flow through fish cages is vital for fish welfare, affecting factors such as oxygen levels, temperature regulation, stress reduction and the disposal of waste and contaminants. The presence of dissolved oxygen and temperature can significantly impact fish welfare by influencing metabolism and, consequently, growth (Ristolainen et al., 2022). In addition, since this cage culture operates in an open system, it is crucial to consider the potential consequences of natural calamities such as floods and unpredictable temperature changes. Insights from studying other economically important species, such as Nile tilapia, underscore the importance of assessing the ecological carrying capacity for intensive cage aquaculture, as demonstrated in a large hydroelectrical reservoir (David et al., 2015).

The availability of high-quality genetic snakeskin gourami fingerlings significantly influenced production yields, aligning with findings by Indrambarya (1980) and underscoring the need for an animal breeding program to ensure a consistent supply. Similar success stories in blue tilapia (*Oreochromis aureus*; Thodesen et al., 2013) and rainbow trout (Vandeputte et al., 2022) highlighted the economic benefits derived from traits developed through multiple generations of selective breeding. Notably, these achievements often involved meticulous individual/family tagging procedures, such as passive integrated transponder or visible implant elastomer options. Additionally, tagging provides a means to uniquely identify individual fish within a population, serving as a suitable and precise marking technique for distinguishing and maintaining different stocks within a shared environment over time. This allows for monitoring growth rates, survival rates and other individual-specific traits.

Recommendations involve extending trait analysis to include body shape aspects, including condition factor (K; a metric used to assess an individual fish's overall well-being and health), body length, depth, thickness and volume. Insights from studies in various fish species (Trong et al., 2013; Reis Neto et al., 2014; Freitas et al., 2023) could guide this exploration, aligning traits with consumer preferences. Notably, consumers prefer the distinctive plum body shape of the snakeskin gourami, making it crucial to consider these traits for optimization. Recently intensive cage culture for snakeskin gourami has emerged in the aquaculture industry. Research on this cultivation approach could be applicable in various environments, with

the identification of the crucial factors suitable for it being advantageous in delivering valuable information to farmers and enhancing fish production. Furthermore, an economic analysis is necessary that involves determining the net revenue and benefit-cost ratio of the cage culture operation.

Conclusion

The current study on intensive cage culture of snakeskin gourami in the Mae Klong River has provided important implications for the aquaculture industry. Prioritizing larger females maximized profitability, while insights into sex determination benefited breeding programs. Winter initiations offered moderate outputs with manageable costs, whereas culturing in summer optimized growth at higher expenses. The rainy season proved less cost-effective due to increased feed and fingerling costs, posing financial risks. High survival rates highlighted intensive cage culture's potential viability. Considering water quality and consumer preferences is crucial for sustainable aquaculture in Kanchanaburi, Thailand, guiding practices for snakeskin gourami cultivation.

Conflict of Interest

The authors declare that there are conflicts of interest.

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