

Natural Breeding Technique of Saline Tilapia (*Oreochromis niloticus*) at UPTD Marine and Brackish Water Aquaculture Center Teluk Buo West Sumatra

Teknik Pembenihan Nila Salin (*Oreochromis niloticus*) Secara Alami di UPTD Balai Perikanan Air Laut Dan Payau Teluk Buo Sumatera Barat

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ABSTRACT

Saline tilapia (*Oreochromis niloticus*) culture is a strategic option for utilizing brackish coastal waters. This study aimed to evaluate natural hatchery techniques, identify success factors, and provide recommendations to improve productivity. Conducted from July to September 2025 at the Marine and Brackish Water Fisheries Center, Teluk Buo (Padang), the study used direct and participatory observation. Data included fecundity, feed consumption, fry survival, and water quality. Spawning was carried out naturally with a 1:3 male-to-female ratio at 17–18 ppt salinity. Results showed high fecundity (3,500 eggs per female) and fry survival rate of 83%. Daily feed consumption was 1.2 kg for 80 broodstock. Water quality remained optimal (pH 7, temperature 28–30°C, salinity 17–18 ppt, DO >5 mg/L). Hatchery success was influenced by broodstock quality, high-protein feed, water management, and biosecurity. These findings can support the development of saline tilapia hatchery in coastal Indonesia.

Keywords: fecundity, survival, water quality, saline tilapia, breeding

ABSTRAK

Budidaya ikan nila salin (*Oreochromis niloticus*) merupakan alternatif strategis dalam pemanfaatan perairan payau di wilayah pesisir. Penelitian ini bertujuan mengevaluasi teknik pembenihan alami, mengidentifikasi faktor keberhasilan, serta memberikan rekomendasi untuk meningkatkan produktivitas. Penelitian dilakukan pada Juli–September 2025 di Balai Perikanan Air Laut dan Payau Teluk Buo, Padang, dengan metode observasi langsung dan partisipatif. Data yang dikumpulkan meliputi fekunditas induk, konsumsi pakan, kelangsungan hidup larva, dan kualitas air. Pemijahan dilakukan secara alami dengan rasio jantan dan betina 1:3 pada salinitas 17–18 ppt. Hasil menunjukkan fekunditas tinggi (3.500 telur per induk) dan tingkat kelangsungan hidup larva sebesar 83%. Konsumsi pakan harian sebesar 1,2 kg untuk 80 induk. Kualitas air berada pada kondisi optimal (pH 7, suhu 28–30°C, salinitas 17–18 ppt, DO >5 mg/L). Keberhasilan pembenihan dipengaruhi oleh kualitas induk, pakan berprotein tinggi, pengelolaan kualitas air, dan penerapan biosekuriti. Hasil ini dapat menjadi acuan pengembangan teknologi pembenihan nila salin di wilayah pesisir Indonesia.

Kata Kunci: fekunditas, kelangsungan hidup, kualitas air, nila salin, pembenihan

INTRODUCTION

Aquaculture is a strategic sector in supporting global food security,



particularly as a provider of sustainable animal protein. According to the FAO (2022), global aquaculture production has reached more than 87.5 million tons, with freshwater fish dominating the market, contributing approximately 56%. This trend reflects the increasing dependence of the global community on aquaculture as a vital and strategic food source. Indonesia is one of the world's largest aquaculture producers, with total aquaculture production reaching 14.43 million tons and an economic value exceeding IDR 120 trillion (KKP, 2021). Tilapia (*Oreochromis niloticus*) occupies a crucial position in the aquaculture world due to its rapid growth, ease of maintenance, tolerance to diverse environmental conditions, and stable and growing market demand. In 2023, national tilapia production was recorded at approximately 1.3 million tons, making it one of the most important sources of fish protein for the Indonesian people (KKP, 2023).

However, the development of tilapia cultivation in freshwater faces challenges in the form of increasingly limited land due to competition with the agricultural sector and land conversion. This situation has driven innovation through the development of saline tilapia, namely tilapia that have been adapted to live in saline media by utilizing brackish water areas, especially in coastal areas that still have significant potential but have not been optimally optimized. The adaptability of tilapia to salinity has been proven by various studies. The results of research by Dahril et al. (2017) reported a survival rate of more than 90% at salinities of 11 to 20 ppt indicating the euryhaline tolerance of tilapia to salinity changes. Furthermore, Rahman and Putra (2021) stated that gradual salinity adaptation can significantly increase the growth and survival of tilapia fry, in line with the findings of Zuib et al. (2024) that appropriate salinity adaptation significantly contributes to the increased growth and survival of sultana tilapia fry.

Saline tilapia has several advantages over conventional freshwater tilapia, including higher disease resistance, adaptability to a wide temperature range, better feed utilization efficiency, and a relatively fast growth rate (Setiawati and Suprayudi, 2003; Halija et al., 2019). These advantages make saline tilapia a highly potential commodity for development in coastal areas, including as

an alternative to the use of non-productive ponds (Halim et al., 2025). The success of saline tilapia cultivation is largely determined by the availability of quality seeds, so appropriate seeding techniques are key to the successful development of this commodity (Yoanda et al., 2023).

The success of saline tilapia hatchery is influenced by a number of interrelated technical factors, including broodstock management, natural spawning techniques, egg quality, the incubation process, and water quality management during hatchery. Water quality parameters such as temperature, pH, dissolved oxygen (DO), and salinity are crucial environmental factors in determining the success of fertilization, egg hatching, and larval survival (Junda et al. 2023; Pramleonita et al., 2018). Research by Prihatini et al. (2023) shows that salinity significantly affects the embryogenesis process and hatchability of saline tilapia eggs, while Malik et al. (2018) confirms that optimal salinity management during the spawning phase significantly determines the fertilization rate and larval survival. Furthermore, proper feed management during the nursery phase has also been shown to play a crucial role in supporting the growth and survival of fry (Sari and Barawas, 2024; Angriani et al. 2020).

In West Sumatra, the development of saline tilapia hatchery technology is still in its early stages, one of which is being carried out at the UPTD of the Marine and Brackish Water Fisheries Center in Teluk Buo, Padang City. This center has strategic potential as a center for the development and supply of superior saline tilapia seeds to support coastal fisheries cultivation in the West Sumatra region. However, scientific documentation regarding natural saline tilapia hatchery techniques in this location is still very limited, so a comprehensive study is urgently needed as a basis for technology development and the preparation of practical recommendations. This study aims to examine in depth the natural saline tilapia (*Oreochromis niloticus*) hatchery technique, analyze the factors that influence its success, and provide practical recommendations to increase the productivity of saline tilapia hatcheries in brackish waters. With the application of appropriate and standardized hatchery technology, the potential of brackish water areas in coastal areas can be optimized to produce superior and high-quality seeds, while supporting community

economic growth in the field of coastal fisheries cultivation.

RESEARCH METHODS

Time and Place of Research

The research was conducted over two months, from July 1 to September 1, 2025, at the Teluk Buo Marine and Brackishwater Fisheries Center (UPTD), Padang City, West Sumatra Province. The research location was chosen because it is one of the units developing saline tilapia seeding technology to produce superior seeds that are adaptable to brackish waters.

Research Tools and Materials

The tools used in this study were: broodstock ponds, aeration installations, digital scales, DO meters, pH meters, thermometers, basins, grading tools, nets, rulers, notebooks, and cameras for documentation. The materials used were: tilapia broodstock and fish feed.

Method of Collecting Data

This study used direct and participatory observation methods, with active involvement in the entire process of saline tilapia seeding. Data collected through daily observations included recording water quality parameters, calculating daily feed intake, and the number of fish deaths. Data collected included broodstock fecundity, daily feed consumption (JKP), fry survival rate, and water quality parameters such as temperature, pH, dissolved oxygen (DO), and salinity. The collected data were then tabulated and processed using Microsoft Excel.

Stages of Tilapia Seeding

The process of breeding saline tilapia is carried out in concrete ponds with a ratio of male and female parents of 1:3. The stages of activity include: (1) Maintenance of the broodstock' by providing high protein feed (30-35%); (2) Preparation of spawning containers through drying, washing, and sanitation to kill pests and diseases; (3) Selection of parents based on size, health, and maturity of gonads; (4) Natural spawning process with a mass system in the pond; (5) Hatching of eggs which lasts for 3-5 days in the mouth of the female parent; (6) Maintenance of larvae until they become 2-3 cm sized seeds; (7) Seed nursery with a stocking

density of 40 fish/m² until they reach a size of 5-8 cm; and (8) Seed harvesting.

Test Parameters

Fecundity

Fecundity is the number of eggs contained in the ovaries of mature female fish that are ready to be released during spawning.

Daily feed consumption of broodstock (JKP)

The amount of daily feed consumption of the parent is the amount of feed given to the parent every day, calculated using the formula:

$$JKP =$$

$$\text{Average broodstock weight} \times \text{number of stocked broodstock} \times \text{feeding rate}$$

Survival rate life seed (SR)

The survival rate of seeds is the percentage of the number of fish that are alive at the end of maintenance and is calculated using the formula:

$$SR (\%) = \frac{N_t}{N_o} \times 100\%$$

Descriptions:

SR = Survival rate (%)

N_t = Number of final seeds at the end of maintenance (tails)

N₀ = Initial number of seeds for maintenance (tails).

Water Quality

Water quality parameters were compared with the SNI 7550:2009 standard for saline tilapia cultivation. Observed water quality parameters included temperature, pH, dissolved oxygen (DO), and salinity.

RESULTS AND DISCUSSION

Maintenance and Selection of Salin Tilapia Broodstock

Maintaining saline tilapia broodstock is a fundamental step in successful hatchery production. Male and female broodstock are kept separately to prevent premature spawning, which can reduce egg quality and disrupt the reproductive cycle. This separation system also facilitates the selection process and regular monitoring of broodstock condition. Broodstock are fed high-protein feed (30–35%) at 3% of their biomass weight per day, given at two feeding times: morning (8:00 AM) and afternoon (4:00 PM). Providing high-quality feed aims to

maintain optimal broodstock body condition and increase quality gamete production.

Broodstock selection is based on several important criteria. The selected female broodstock has an average weight of 300 g, characterized by an enlarged and rounded abdomen, purplish-red genitalia, and no injuries or physical defects. Meanwhile, the selected male broodstock has a minimum weight of 500 g, characterized by a long and slender body, darker body color, and prominent and pointed genitalia (Figure 1). This selection

process is crucial because the quality of the broodstock will determine the quality of the resulting fry. Healthy and gonadally mature broodstock will produce high-quality eggs and sperm, which ultimately increases the fertilization rate and hatchability of the eggs (Sumarni, 2018). This is in line with Yoanda et al. (2023) who emphasized that broodstock selection based on morphological conditions and gonad maturity is a major determining factor in the success of the tilapia seeding process.



Figure 1. Mature female parent (left) and mature male parent (right)
Source: Field Documentation

Spawning Process and Fecundity

Tilapia spawning is carried out naturally using a mass system in concrete ponds. Prior to spawning, the spawning tank is prepared through a one-day drying process, washing to remove dirt and moss, and sanitizing to kill pests and diseases such as white spot. Selected broodstock are put into the spawning pond with a male-to-female ratio of 1:3. This ratio is chosen to maximize fertilization rates, as one male can effectively fertilize eggs from multiple females (Sasongko, 2022; Prasetyo, 2019).

The spawning process of saline tilapia occurs naturally, where the male parent builds a hollow-shaped nest in the pond floor as a mating site. After fertilization, the female broodstock takes the fertilized eggs and stores them in her mouth to incubate them for 3–5 days until they hatch into larvae. This mouth brooding behavior is a unique characteristic of tilapia that provides optimal protection for eggs and larvae from predators and unfavorable environmental conditions (Syahputra et al., 2023). Malik et al. (2018) added that natural spawning in the right salinity media has been shown to significantly increase

fertilization rates and egg hatchability compared to spawning in pure freshwater.

Fecundity is an important factor that determines the level of productivity in fish breeding. Based on results research, the fecundity of female saline tilapia broodstock at the UPTD BPBALP Teluk Buo reached 3,000 eggs per broodstock. This high fecundity value is influenced by several factors, including the quality and quantity of feed provided, the condition of the aquatic environment, and the size and age of the broodstock (Amalia et al., 2018). According to Bahri et al. (2023), the fecundity value of tilapia broodstock ranges from 953-3,565 eggs per broodstock, so the results obtained in this study are included in the very good category and indicate that the broodstock being maintained are in optimal condition. Prihatini et al. (2023) stated that appropriate salinity conditions of the rearing media contribute positively to egg quality and the fecundity value of female saline tilapia broodstock, which ultimately affects hatchability and larval survival.

Seed Maintenance and Nursery Techniques

After the spawning process, the fry are reared in spawning ponds until they reach a size of 2–3 cm before being harvested and transferred to nursery tanks. The rearing period in the spawning ponds lasts approximately 30 days, with feeding consisting of plankton growing around the pond and fine artificial feed. The larval to fry stage is the most critical phase in hatchery production because it is highly susceptible to changes in water quality and disease attacks (Vinasyiam et al., 2022). Mendrofa and Zebua (2025) emphasized that abiotic and biotic factors such as temperature, salinity, stocking density, and fish adaptability are the main determinants of survival during this critical phase.

The seed harvesting process is carried out in the morning using a gradual water draining method. The seeds are harvested using a fine-mesh sieve to avoid injury or stress to the seeds. The harvested seeds are then graded or sorted by size using a grading tool with holes measuring 2–3 cm. This grading process is crucial for obtaining uniform seeds, thus simplifying subsequent maintenance management and reducing competition for feed (Suprpto & Salsabila, 2018).

Nursery at the UPTD BPBALP Teluk Buo is carried out in stages in four ponds based on seed size: nursery pond 1 for 2–3 cm size, nursery pond 2 for 3–5 cm size, nursery pond 3 for 5–8 cm size, and nursery pond 4 for 8–10 cm size. The seeds are stocked with a stocking density of 40 fish/m². The right stocking density is very important because a stocking density that is too low reduces the efficiency of production space, while a stocking density that is too high causes competition for movement space which inhibits growth and increases the risk of death (Frizca et al., 2014). Silawane et al. (2024) added that setting an appropriate stocking density in a staged nursery system has proven effective in increasing the growth rate and size uniformity of saline tilapia seeds.

Before stocking, the seeds are acclimatized to prevent stress from changing environmental conditions. Acclimatization is performed by placing a bucket containing seeds and water into the nursery pond and waiting for 1 minute before slowly releasing the seeds. This process is crucial because sudden changes in temperature, pH, or salinity can cause stress and even death in the seeds (Suprpto & Salsabila, 2018). Zuib et al. (2024) demonstrated that gradual salinity

adaptation significantly improves the growth and survival of tilapia seeds compared to sudden salinity changes.

Tilapia Feed Management

Feed management is a crucial aspect of successful tilapia cultivation. Feed plays a crucial role in determining fish growth, health, and survival (Amalia et al., 2018). At the Teluk Buo Aquaculture and Aquaculture Development Unit (UPTD BPBALP), feed management is carried out in a planned and systematic manner, taking into account nutritional requirements at each stage of fish growth.

The types of feed used include natural and artificial feed. Natural feed consists of plankton that grows naturally around the spawning ponds and rearing tanks, while artificial feed consists of floating and sinking feed. For saline tilapia broodstock, floating feed sizes of min 1 to min 3 are used, given at 3% of the biomass weight per day. Based on the research results, the daily feed consumption (JKP) of tilapia broodstock is 1.2 kg (20 male broodstock and 60 female broodstock, average weight 500 g, FR 3%). Feeding is carried out twice a day in the morning (08:00) and afternoon (04:00). A combination of floating and sinking feed is applied to increase protein content to 30–35% according to the optimal needs of tilapia. Setiawati and Suprayudi (2003) stated that feed efficiency and growth rate of tilapia are significantly influenced by the appropriate feeding rate, where feeding of 3% of the biomass weight per day is considered efficient for the broodstock maintenance phase. Feeding of seeds can be seen in Figure 2.

For fry, in addition to artificial feed, additional feed is provided in the form of shrimp feed containing 35% protein. Providing shrimp feed to saline tilapia fry aims to improve the growth and health of the fry because it is rich in essential amino acids, minerals, and vitamins needed for optimal development. Angriani et al. (2020) demonstrated that providing the correct feed dosage to saline tilapia fry significantly affects the growth and survival of the fry. The frequency of feeding for fry is higher, namely 3–4 times daily with an amount of 5–10% of the biomass weight, adjusted according to the size and age of the fry. Sari and Barawas (2024) emphasized that appropriate feeding techniques during the saline tilapia nursery phase, both in terms of frequency,

quantity, and type of feed, are key factors in supporting optimal growth and survival

of fry.



Figure 2. Feeding tilapia fry
Source: Field Documentation

Survival Rate

Survival rate (SR) is one of the main indicators of success in fish breeding and maintenance. Based on data obtained during the study, the survival rate of saline tilapia fry at the UPTD BPBALP Teluk Buo reached 83%. This value is higher than the results of research by Francisca and Muhsoni (2021), who maintained tilapia at different salinities with a survival rate of + 50%, which stated that the survival rate for tilapia fry production in brackish waters is at least 75%. Achieving a survival rate of 83% indicates that the breeding and maintenance techniques implemented at the UPTD BPBALP Teluk Buo have been running well and effectively.

This high survival rate is influenced by several important interrelated factors. First, good broodstock quality produces strong eggs and larvae, thus increasing their resistance to environmental conditions (Sumarni, 2018). Second, optimal feed management ensures that the fry receive sufficient nutrition for growth and immune system development (Amalia et al., 2018). Third, good water quality management creates a conducive environment for fry survival (Junda et al., 2023). Fourth, appropriate stocking densities reduce competition and stress on the fry (Frizca et al., 2014). These results align with those of Dahril et al. (2017), who reported a survival rate of over 90% at salinity levels of 11–20 ppt, and Angriani et al. (2020), who demonstrated that proper feed management significantly contributes to increased survival of saline tilapia fry. Factors that influence fish survival

include abiotic and biotic factors, where the physical-chemical conditions of the water such as temperature, pH, salinity, and dissolved oxygen, as well as biotic factors such as stocking density and the adaptability of the fish, together determine the success of maintenance (Cahyono, 2009).

Water Quality Parameters

Water quality is a crucial factor in the success of tilapia seeding. Monitored water quality parameters include pH, temperature, salinity, and dissolved oxygen (DO), which are routinely measured twice daily, in the morning and evening, to ensure optimal water conditions for fish survival.

The water acidity (pH) during the study ranged from 7 to 7 at all rearing locations. This pH value falls within the optimal range for saline tilapia cultivation according to SNI 7550:2009, which stipulates an optimal pH of 6.5–8.5. Saputry and Latuconsina (2022) state that the optimal pH for tilapia is in the range of 7.0–8.0. Extreme pH changes can cause metabolic disorders, stunted growth, and make fish susceptible to disease and stress (Pramaleonita et al., 2018).

Salinity is an important factor affecting the growth and survival of saline tilapia. Measurement results show a salinity range of 18 ppt in the morning and 17 ppt in the afternoon, which is still within the optimal range for saline tilapia cultivation. According to Rahman and Putra (2021), saline tilapia can tolerate a salinity range of 0–25 ppt with an optimal range of 10–20 ppt to support better growth. This is supported by Mirera and Okemwa (2023) who proved that tilapia (*Oreochromis niloticus*) can

tolerate high salinity with the best growth performance at medium salinity. At excessively high salinity (more than 25 ppt), fish show a decrease in growth rate due to increased energy used for the osmoregulation process (Mohamed et al., 2021). De Azevedo et al. (2015) also reported that the response of tilapia to various levels of water salinity is greatly influenced by the osmoregulatory ability of the fish's body, where salinity above the tolerance threshold causes a significant decrease in growth.

The measured water temperature ranged from 28°C in the morning to 30°C in the afternoon. This difference is due to the intensity of sunlight entering the water body. These temperature values are still in accordance with the requirements of SNI 7550:2009, which stipulates an optimal temperature range of 25–32°C. Water temperatures that are too high can affect oxygen solubility in the water, potentially causing stress or even fish death. Hui et al. (2014) also

emphasized that temperature, salinity, and pH jointly affect the fertilization percentage and hatchability of tilapia eggs, so integrated control of these parameters is essential in hatchery management.

Dissolved oxygen (DO) is a vital factor because it is needed by all organisms for respiration and metabolic processes. According to SNI 7550:2009, the optimal DO for tilapia cultivation is more than 3 mg/L. A safer oxygen concentration in aquaculture ranges from 5–7 mg/L (Telaumbanua, 2025). A decrease in dissolved oxygen concentration to below 5 mg/L can cause disruption to the reproductive system, growth, and even death of cultivated organisms. Based on observations, all water quality parameter values for saline tilapia cultivation at the UPTD BPBALP Teluk Buo are still within the normal category and support successful seeding, as presented in Table 1.

Table 1. Water quality parameters during saline tilapia seeding

Parameter	Morning	Afternoon	SNI 7550:2009 Standard
pH	7	7	6.5-8.5
Temperature (°C)	28	30	25-32
Salinity (ppt)	18	17	0-20
DO (mg/L)	>5	>5	>3

Source: Data Processing

CONCLUSION

Saline tilapia (*Oreochromis niloticus*) hatchery technique at the Teluk Buo Marine and Brackish Water Fisheries Center (UPTD) has shown good results with a seed survival rate of 83%. Seeding success is greatly influenced by three main factors: good broodstock quality, optimal feed management with a protein content of 30-35%, and well-maintained water quality management according to SNI 7550:2009 standards. The fecundity of the female broodstock, which reaches 3,500 eggs, indicates optimal broodstock condition and supports high seeding productivity. The broodstock adaptation process in a 10-20 ppt salinity medium has been proven effective in increasing fertilization rates and egg hatchability. The natural spawning technique with a mass system and a male-female broodstock ratio of 1:3 provides good efficiency in seed production. The

implementation of strict biosecurity, appropriate stocking density settings, and regular water changes have been proven to be able to maintain health and improve seed survival during the maintenance period until the nursery stage.

RECOMMENDATIONS

It is recommended that further research be conducted to evaluate the effects of different salinity levels, feed formulations, and stocking densities on the growth and survival of saline tilapia fry in order to optimize hatchery performance and enhance production efficiency, while ensuring the sustainability of seed production under varying environmental conditions.

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