Case study

NATURAL SPAWNING TECHNIQUE OF KOI FISH (*Cyprinus carpio*) IN THE CIPARANJE INLAND FISHERIES AREA, SUMEDANG, INDONESIA

ABSTRACT

The Ciparanje inland aquaculture area has emerged as a hub for breeding ornamental fish, with koi fish being a prominent species. The increasing demand for koi fish has led to a surge in koi aquaculture businesses. What sets koi fish apart from some other fish species is their ability to breed throughout the year, unaffected by specific seasons. However, in their natural habitat, koi fish typically spawn at the onset of the rainy season, triggered by the enticing aroma of the soil. The growth of koi fish is influenced by various factors, including fish species, genetic characteristics, feeding efficiency, disease resistance, and environmental conditions such as water and feed quality, as well as stocking density. To ensure the production of top-quality koi fish fry, it is crucial to employ the appropriate spawning techniques. In this study, a participative approach was employed to investigate and report on the natural spawning procedures of koi fish in the Ciparanje inland aquaculture area, managed by Padjadjaran University. The natural spawning method implemented in this area encompasses several crucial processes, including the preparation of spawning ponds, selection of breeding stock, egg hatching, and larvae rearing. A total of 90,175 eggs were collected from the examined koi broodstock during the spawning activities, and an impressive 80% of these eggs successfully hatched. The calculated Hatching Rate (HR) reached 96.5%, indicating a high level of achievement in the hatching of koi fish larvae.

Keywords: aquaculture, Ciparanje, koi fish, spawning method

1. INTRODUCTION

The Ciparanje Inland Fisheries Area has a land area of ±5 hectares. Land area is used for various facilities including office buildings, hatcheries, green houses, mess houses, feed manufacturing houses, and roads. While the rest is used for water storage, fish ponds, and rice fields. The Ciparanje Inland Fisheries Area is situated within Padjadjaran University in Jatinangor, specifically in Cileles Village, Sumedang Regency. It is categorized as a category III open laboratory that focuses on various activities related to freshwater biota, including hatchery operations, maintenance, and technology development in an open system. As part of the development, the Ciparanje experimental pond was constructed, along with the establishment of a wet laboratory dedicated to hatchery activities. The area is involved in the cultivation of different types of commodities, namely consumption fish, ornamental fish, and local fish. The consumption fish category comprises tilapia, Pangasiidae catfish, grass carp (*Ctenopharyngodon idella*), and Clariidae catfish. Ornamental fish include koi fish, comet goldfish, koki goldfish (*Carassius auratus*), and tengadak fish (*Barbonymus schwanenfeldii*).

Additionally, the local fish commodities being developed in the area consist of nilem fish (*Osteochilus vittatus*), beureum panon fish (*Puntius orphoides*), tawes fish (*Barbonymus gonionotus*), betutu fish (*Oxyeleotris marmorata*), and baung catfish (Mystus).

Koi fish is one of the ornamental fish developed in this area. Koi fish (*Cyprinus carpio*) belong to the carp family and are highly valued ornamental fish. They possess vibrant body colors with various patterns, making them visually appealing [1]. According to [2], the characteristics of a good koi fish include an ideal body shape, a straight spine, vivid and contrasting colors, calm yet agile movements, and overall health. The attractive body colors of koi fish contribute to their promising market potential [3]. In fact, data from the Ministry of Marine Affairs and Fisheries (2010) reveals that the export value of koi fish reached US$10 million in 2009 and increased to US$12 million in 2010. The high demand for koi fish has led to an increase in koi fish farming ventures [4].

The life cycle of koi fish begins with the development of eggs and sperm in their gonads, followed by the spawning process, resulting in the hatching of larvae that eventually grow into mature individuals. Unlike some other fish species, koi fish can spawn throughout the year without being influenced by specific seasons. However, in their natural habitat, koi fish tend to spawn during the onset of the rainy season, as the scent of the soil acts as a stimulus for spawning. Typically, koi fish prefer to spawn during the nighttime hours, with spawning activity continuing until the approach of sunrise. During the spawning process, koi fish actively seek out sheltered areas with ample vegetation, such as aquatic plants or grass that covers the water's surface. These substrates serve as attachment points for the eggs and aid in stimulating the spawning behavior [5].

The growth of koi fish is influenced by various factors, including fish species, genetic traits, feeding efficiency, disease resistance, and environmental conditions such as water quality, feed quality, and stocking density [6]. Low survival rates and slow growth rates are common challenges in koi fish farming. To address these issues, it is crucial to provide proper feeding, considering the size, quantity, and nutritional content of the feed [7]. The feeding process directly impacts the metabolism, survival, and growth rate of koi fish seeds (*Cyprinus carpio*). Additionally, selecting superior parent fish is essential to obtain healthy and high-quality seeds.

Koi fish inhabit freshwater environments, including both public and controlled bodies of water. They are highly sensitive to changes in the quality of their environment, emphasizing the importance of maintaining suitable conditions for their well-being. Koi fish thrive within altitudes ranging from 150 to 600 meters above sea level (asl), while temperatures of 25-30℃ are conducive to their optimal development. As omnivores, koi fish belong to the category of fish that consume both plant and animal matter. They primarily feed on vegetation and organisms found along the water's edges and at the bottom of their habitat [5].

Therefore, employing the correct spawning technique is vital to obtain the best koi fish fry. Given the increasing demand for ornamental fish seeds as a hobby and business opportunity, the process of spawning koi fish holds significant importance. Koi fish farming can be a profitable venture for farmers both domestically and internationally. The objective of this paper is to report and explore the natural spawning techniques of koi fish conducted in the Ciparanje inland fisheries area, which is under the purview of Padjadjaran University.

2. MATERIAL AND METHODS

The research was conducted in the Ciparanje Inland Fisheries Area, located in Cileles Village, Jatinangor District, Sumedang Regency. Geographically, the area of Ciparanje Inland Fisheries spans from 107°76'83.9" E to 107°76'90.7" E longitude and from 06°91'21.9" S to 06°91'31.4" S latitude. It is situated at the foot of Mount Manglayang, approximately 700 meters above sea level. The soil type in this area is classified as inceptisol, as described by [8].

The participatory method was employed in this activity at the Ciparanje Inland Fishing

Area at Padjadjaran University. According to [9], the participatory method involves direct and active involvement in field activities. By actively participating in these activities, valuable data and information on natural koi fish (*Cyprinus carpio*) spawning techniques can be obtained.

The data collection process involves two main approaches: primary data collection and secondary data collection. Primary data refers to information obtained through direct observation, interviews, and active participation. On the other hand, secondary data refers to data or information collected and reported by individuals for specific purposes or scientific studies.

Primary data is collected directly from the source and recorded for the first time [10]. It is unprocessed data obtained firsthand. Various methods can be used to collect primary data, including observation, interviews, active participation, and the use of specific measurement instruments tailored to the research objectives.

During this project, observations were conducted to document the activities and record relevant information pertaining to koi fish spawning activities in the Ciparanje Inland Fishery Area. Additionally, interviews were conducted with the staff involved in order to gather insights into the background of koi spawning technical activities, the organizational structure, the workforce, the types of activities, and the common challenges encountered during koi spawning activities in the Ciparanje Inland Fisheries Area. Secondary data was also collected and utilized in this activity. As stated by [11], secondary data refers to primary data that has undergone additional processing, such as presenting it in the form of graphs, tables, diagrams, images, and other formats, making it more informative for various stakeholders and researchers for further analysis. Secondary data can be obtained from libraries or from reports and publication published by previous researchers.

3. RESULTS AND DISCUSSION

3.1 Preparation of the Spawning Pond

According to [12], natural spawning refers to the process of spawning that occurs without any hormonal stimulation or other artificial treatments. In the Ciparanje Inland Fisheries Area, the breeding koi fish undergo natural spawning activities, which involve various steps such as preparing spawning containers, selecting brood fish, carrying out the spawning process, hatching the eggs, and rearing the larvae.

The initial step in the natural spawning process of koi fish involves preparing the container, which includes the pond, *hapa*, and *kakaban*. To begin with, the pond is dried for two days to break the cycle of pests and diseases. Subsequently, the pond undergoes liming, where lime is evenly spread at a dose of 50 g/m^2 and left for one day. After the liming process, fertilization is conducted using chicken manure, applied at a dose of 200–500 g/m^2, and stored in sacks. Once the drying, liming, and fertilizing processes are complete, the pond is filled with water to a height of 50–70 cm, followed by the installation of *hapa* and *kakaban*.

The *kakaban* is constructed using palm fiber clamped to bamboo slats and securely nailed. A well-made *kakaban* consists of long, flat fibers measuring 120 cm in length and 40 cm in width. The number of *kakaban* required depends on the size of the female parent, typically ranging from 4 to 6 pieces per kilogram of the female parent. To ensure buoyancy, the *kakaban* is arranged on an intact piece of bamboo, which is placed on top of the *kakaban* group and tied together to prevent scattering during the spawning of the parent pair.

Before installation, the *kakaban* is thoroughly cleaned, washed, and rinsed to remove any mud or debris. The *kakaban* is then installed after the pond has been filled with water. Continuous water flow is maintained into the spawning pond to stimulate the koi pair to

engage in spawning activities [12].

Fig. 1. Spawning pond for Koi fish in Ciparanje site

3.2 Parent Selection

Proper and accurate parent selection plays a vital role in enhancing fecundity and maximizing the number of produced seeds, as emphasized by [13]. Sex determination is a crucial step in parent selection, achieved through the stripping method on the abdomen. The optimal age for spawning koi fish ranges from 2 to 3 years, as suggested by [12]. Careful consideration must be given to selecting parents that exhibit mature sexual organs and physically mature bodies. Maturing sex organs indicate the male parent's ability to produce sperm and the female parent's capability to produce mature eggs. Furthermore, physically mature prospective parents are essential for ensuring their readiness to become productive breeders. It is important to note that stressed or unhealthy koi fish (*Cyprinus carpio*) may not engage in spawning behavior. Thus, selecting healthy and robust broodstock is crucial for successful koi fish (*Cyprinus carpio*) spawning.

Fig. 2. Parent selection process for Koi fish

When selecting parents, cultivators should be mindful of important factors to avoid mistaking males for females. To aid in distinguishing between male and female koi fish (*Cyprinus carpio*), a range of specific differences can be observed, as outlined in Table 1 [14]

Table 1. Specific Differences between Male and Female Koi Fish (*Cyprinus carpio*)

Characteristics	Male	Female
Body	Slim	Large
Stomach	Small	Enlarge

Anus	Protrudes	Concave inwards
Abdomen to anus	If pressed, will emit a milky discharge	If pressed, will emit a clear yellowish liquid
Swimming moves	Agile	Slow
Growth	Faster	Slow

3.3 Spawning Process

As described by [15], broodstock with mature gonads is carefully selected and released into the prepared spawning ponds. The spawning process takes place within the *hapa* nets that have been meticulously set up. In the case of koi fish (*Cyprinus carpio*) spawning, it begins with the preparation of the *kakaban*. Initially, the female parent is introduced to the pond to allow for proper acclimatization, minimize stress, and ensure optimal egg production.

Fish spawning occurs by pairing male and female koi fish in dedicated fish spawning ponds, typically maintaining a ratio of 3 males to 1 female. The actual mating of the koi fish takes place naturally and predominantly during nighttime hours, often around midnight, with a spawning interval ranging from 11 to 18 hours after pairing [16]. The male koi fish actively pursues the female fish, carrying her around the prepared substrate, and releasing sperm as the female fish deposits her eggs on the substrate. The eggs, once fertilized, adhere to the *kakaban*, which serves as a supportive medium for egg incubation

Observable signs of male fish readiness to spawn include their energetic pursuit of female fish, their carrying of the female fish around the prepared substrate, and the subsequent release of sperm upon the female fish releasing eggs in proximity to the substrate [16]. Meanwhile, the female fish spawns by releasing eggs onto the provided substrate, ensuring that the eggs firmly adhere to their surface.

3.4 Hatching Eggs

Following the spawning process, the fertilized eggs become attached to the prepared *kakaban*, and the male and female koi fish are returned to the main pool. To ensure the well-being of the eggs, dry leaves from *ketapang* trees (*Terminalia catappa*) and banana leaves are spread throughout the pond. This practice effectively prevents the growth of fungi that could harm the koi fish's (*Cyprinus carpio*) eggs. It is important to note that fertilized eggs are considered healthy if they exhibit a bright yellow color, indicating the presence of viable embryos. Conversely, eggs that appear pale white in color are damaged or unlikely to hatch successfully.

The hatching process of koi fish (*Cyprinus carpio*) eggs in aquaculture ponds typically takes around 2–3 days. During this period, the developing embryos often undergo repositioning within the eggshell due to limited space. As a result of these movements, the softer parts of the eggshell start to break. Generally, the tail end of the embryo breaks free first, followed by the rest of the body. However, it is not uncommon for the heads of the embryos to break free first due to their larger size. Throughout the staging process of the eggs, some non-viable eggs may be observed.

This occurrence highlights that not all fertilized eggs will successfully hatch into larvae. Unhatched eggs can be attributed to poor egg quality, which is often indicated by the presence of a water mixture during egg collection. Additionally, the eggs can stick together or overlap each other during distribution in the hatchery filter, resulting in disrupted oxygen circulation and subsequent oxygen deprivation, leading to the death of the affected eggs. Dead eggs are susceptible to fungal infection by *Saprolegnea* sp., and if infected eggs come into contact with fertile ones, fungal transmission can occur [17].

The hatching of koi fish eggs typically takes around 30–36 hours or 2-3 days. The egg count was conducted through direct observation of the 11 utilized *kakabans*. The calculation revealed a total of 90,167 successfully fertilized koi fish eggs, with an estimated hatching rate of approximately 80%, considering the number of larvae observed swimming along the pond's edges. On the fourth day, the *kakabans*, which served as the attachment medium for

the eggs, are removed, as it is anticipated that all the eggs have hatched completely by that time, reaching a 100% hatching rate.

Fig. 3. Fertilized koi fish eggs

After the eggs have successfully hatched, the Hatching Rate (HR) or hatching degree is determined as a measure of the hatching success. The HR is calculated by conducting two separate samplings of the larvae from the total number of fertilized eggs using a petri dish. The number of hatched eggs is then divided by the number of fertilized eggs and multiplied by 100% to obtain the HR percentage. During the initial sampling, a HR of 97% was recorded, while the second sampling yielded a HR of 96%. Taking the average of these two sampling stages, the overall HR is calculated to be 96.5%.

3.5 Larvae Rearing

The survival of larvae, particularly in the early stages, is highly dependent on their feeding. Without an adequate food supply, larvae can experience high mortality rates in a short period of time. Providing optimal feeding conditions in terms of both quality and quantity is crucial for enhancing their survival [18].

The success of achieving a high survival rate for koi fish larvae is closely tied to the care they receive. During the critical period in the early stages of their life cycle, which occurs before and after they consume their yolk sac and transition to external feeding, the behavior and movement of the larvae in their search for food play a significant role in their overall success [17].

To promote the growth of microorganisms, which serve as natural food for koi larvae, four sacks of perforated husk fertilizer were introduced into the larval-rearing pond. This practice encourages the proliferation of microorganisms, creating a favorable environment for the larvae's nutritional needs.

4. CONCLUSION

The natural spawning method employed in the Ciparanje Inland Fishery Area encompasses several essential steps, including the preparation of spawning ponds, broodstock selection, egg hatching, and larvae rearing. Through the conducted spawning activities, a total of 90,175 eggs were obtained from the sampled koi broodstock, with 80% of the fertilized eggs successfully hatching. The calculated Hatching Rate (HR) averaged an impressive 96.5%, indicating a high level of success in the hatching of koi fish larvae. Moving forward, it would be beneficial to prioritize the implementation of enhanced biosecurity measures in the pond area to minimize the potential spread of pathogens during koi fish spawning activities.

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