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Fish Cultivation Techniques for Common Carp (*Cyprinus carpio* Linn.) Strain "Mantap" at Center for Freshwater Fish Cultivation (BBPBAT) Sukabumi, West Java, Indonesia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The cultivation of Carp (*Cyprinus carpio,* Linn) in hatcheries can be approached through various methods, including traditional, semi-intensive, and intensive techniques. Presently, many hatchery operations still adhere to traditional practices. This activity aimed to actively engage with, study, apply and report advanced techniques in the breeding of Common Carp (*Cyprinus carpio*, Linn). This practical training was conducted between May 22, 2023, and July 14, 2023, at the Sukabumi Freshwater Aquaculture Center (BBPBAT). Data collection during the activity encompassed both

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primary and secondary sources. Natural spawning of Common Carp was executed with a male-to-female sex ratio of 2:1, utilizing 60 male broodstock with an average weight of 500 grams and 30 female broodstock weighing around 2,000 grams each. The results of this spawning procedure yielded a fertilization rate of 82.77% and a hatching rate of 68%. Subsequently, 600,000 larvae were obtained from the spawning process. These larvae were then transferred to a nursery pond with a stocking density of 300 individuals per square meter (300 individuals/m^2). Over a span of 24 days in the nursery pond, a survival rate of 51.5% was achieved. This activity served as a hands-on exploration of advanced Common Carp breeding techniques at the BBPBAT facility, providing valuable insights into modern hatchery management.

Keywords: Common carp; fertilization rate; hatching rate; hatchery; survival rate.

1. INTRODUCTION

To fulfill the growing demand for protein from fish consumption, aquaculture businesses have become pivotal in the progress of marine and fisheries development. Fish farming typically encompasses hatching, nursery, and grow-out phases. Hatcheries, in particular, encompass a series of crucial steps, starting with parent selection, pond preparation, spawning, egg hatching, larval rearing, and culminating in seed harvesting.

The common carp is a widely cultivated commodity across various regions of Indonesia, making a substantial economic impact. This is evident in the consistent growth of carp production over the years. For instance, in 2017, national carp production stood at 316,649 tonnes, and this figure surged to an impressive 534,076 tonnes in 2018 or increased 68,7%. The following year, in 2019, production reached an even higher peak of 556,797 tonnes. These statistics underscore the continued high demand for carp commodities.

In addition to increased production, several technological advancements have emerged, including innovations like biofloc technology, Recirculating Aquaculture System (RAS) technology, and aquaponics, all designed for efficient use of limited land resources. Bioflocs, comprising protein-rich heterotrophic bacteria, have proven to be a valuable substitute for conventional feed in the aquaculture of shrimp and fish.

The common carp (*Cyprinus carpio*, Linn) hatchery industry employs various approaches, including traditional, semi-intensive, and intensive methods. Currently, many hatchery operations adhere to traditional practices, where human intervention plays a minimal role, as these processes heavily rely on natural conditions. Seed quality, a fundamental determinant of successful fish farming, is influenced by various factors, including the quality of parent fish and environmental conditions such as water quality, food availability, and disease prevalence. The aim is to pass on desirable traits from parent fish to their offspring, including rapid growth, disease resistance, and the absence of physical deformities.

Several studies have noted that the rapid growth of carp aquaculture has driven a surge in the demand for large quantities of carp seeds. This demand, coupled with the relative ease of seed production, has led to the establishment of small-scale, household-owned hatcheries. These household-owned nurseries are characterized by limited broodstock ownership and a practice of producing broodstock from their own spawning, resulting in a very close kinship among the carp. However, these conditions can induce inbreeding among the produced seeds.

With the advancement of technology, the success of hatchery operations is no longer solely contingent on natural conditions. Human intervention has enabled the manipulation of several key factors influencing fish cultivation. These efforts encompass the utilization of superior seedstock, enhanced spawning techniques through the use of pituitary hormones, artificial fertilization to increase egg fertilization rates, controlled hatching procedures, precise control of water quality and quantity, and the selective breeding of parent fish for desired traits.

The Sukabumi Center for Freshwater Aquaculture (BBPBAT) is renowned for producing strain "Mantap" carp, short for Disease-Resistant Majalaya Carp in bahasa. According to the Directorate General of Aquaculture [1], "Mantap" carp (*Cyprinus carpio*, Linn) has been developed through rigorous selection since 2009, boasting a remarkable 100% resistance to Koi Herpes Virus (KHV) and a notable 74.4% resistance to *Aeromonas hydrophila* bacterial infections, coupled with accelerated growth rates. This endeavor provides a unique opportunity to acquire knowledge and skills related to the hatching of "Mantap" carp. Consequently, the Sukabumi Center for Freshwater Aquaculture (BBPBAT) was chosen as the fieldwork location, serving as the hub for advancing "Mantap" carp cultivation practices. The objective of this activity is to comprehensively investigate the implementation of effective carp (*Cyprinus carpio*, Linn) hatchery techniques, with a particular focus on gaining insights into the specialized "Mantap" carp (*Cyprinus carpio*, Linn) hatchery methodology employed at the Sukabumi City Freshwater Aquaculture Center (BBPBAT) in West Java.

2. MATERIALS AND METHODS

The field activity was conducted at the Freshwater Aquaculture Fisheries Center (BBPBAT) in Sukabumi City, West Java. Various equipment and materials were employed in the "Mantap" carp hatchery operations. Equipment included *hapa* for fish spawning, snare nets for larvae collection, scoop nets for seed retrieval, buckets for transportation, ladles for larvae counting, measuring cups for seed measurement, rulers for measuring size, *kakabans* (made from palm fibre) for fish egg safeguarding, digital scales for weighing, basins for holding samples, plastic packing containers, fine lift nets, aluminum rakes for collecting larvae during harvest, grading buckets, rubber mops for pond cleaning, *jolang* buckets for temporary larval shelter, hoes for pond preparation, stationery for data recording, oxygen cylinders, and rubber bands for packaging. Materials utilized in "Mantap" common carp hatching comprised "Mantap" common carp for observation, fish feed for nutrition, water samples for quality assessment, oxygen for dissolved oxygen supplementation, fertilizer as a nutrient source for natural food growth, fish salt for stress prevention, bacterial control, and pH stabilization in water. Data collection during this activity encompassed two main categories: primary data and secondary data. Primary data were acquired through direct observations, record-keeping, interviews, and active participation, following the methods outlined by Marzuki [2]. Conversely, secondary data were sourced from pre-existing materials and reports, typically found in libraries or from previous research endeavors.

The parameters under examination in this study comprised egg fertilization rate (FR), egg hatching rate (HR), fish survival rate (SR), fish growth rate, and various water quality indicators. Fish growth rates, including measurements of weight and length, were evaluated weekly using a sample of 30 fish. Data analysis employed a descriptive approach, a methodology tailored to portraying specific conditions or events within a particular area. The descriptive method involves not only the collection and retrieval of data but also its comprehensive analysis and subsequent discussion, in accordance with the approach advocated by Ritonga and Nasuki [3].

2.1 Fertilization Rate (FR)

Effendie (1979) outlined a formula for assessing the degree of egg fertilization:

$$FR\ (\%) = P_o/P \times 100\%$$

Where:

FR = Degree of egg fertilization (%)
P = Number of sample eggs
P_o = Number of fertilized eggs

2.2 Hatching Rate (HR)

The Hatching Rate (HR) calculation, according to Ritonga and Nasuki [3] Effendie MI [4], is expressed as follows:

$$HR\ (\%) = (P_t/P_o) \times 100\%$$

Where:

HR = Degree of egg hatching (%)
P_t = Number of hatched eggs
P_o = Number of fertilized eggs

2.3 Absolute Length Growth

Absolute length growth is determined using the following formula:

$$P = P_t - P_o$$

Where:

P = Absolute length growth (cm)
P_t = Average length of fish at the end of rearing (cm)
P_o = Average length of fish at the start of rearing (cm)

2.4 Absolute Weight Growth

Absolute weight growth or weight gain is calculated as per [5] with the formula:

$$H = W_t - W_o$$

Where:

H = Absolute growth (grams)
W_t = Total weight of test fish at the end of the experiment (grams)
W_o = Total weight of test fish at the start of the experiment (grams)

2.5 Survival Rate (SR)

Survival Rate (SR) was calculated using the formula:

$$SR\ (\%) = (N_t / N_o) \times 100\%$$

Where:

SR = Survival Rate (%)
N_t = Number of individuals at time t
N_o = Number of individuals at stocking

2.6 Water Quality

Water quality is a critical factor in fish cultivation, influenced by various dissolved chemicals such as dissolved oxygen (DO), acidity (pH), temperature, and physical substances. In steady common carp cultivation, monitoring water quality is crucial. This includes regular measurements of parameters like temperature, pH, DO, CO_2, NO_2, alkalinity, and NH_4^+. These measurements were conducted at the BBPBAT Sukabumi Water Quality Laboratory.

3. RESULTS AND DISCUSSION

3.1 Broodstock Fish Management

The acquisition of high-quality broodstock stands as a pivotal aspect of the hatching process in aquaculture. It is well recognized that superior fish fry are derived from exceptional broodstock. Therefore, the meticulous maintenance of parent fish assumes paramount significance in the hatchery operations. As per various studies, the phenotypic appearance of organisms is the culmination of interactions between genetic factors and environmental conditions. Even in the same environment, variations in phenotypic appearance are attributed to differences in genotypic expression. It's important to note that, in certain instances, the interplay between genetic factors and the environment can significantly influence the phenotypic traits exhibited by the broodstock population in use.

Broodstock maintenance necessitates dedicated pond facilities, serving as containers for housing these valuable breeding individuals. In line with best practices, male and female common carp parents are meticulously segregated into distinct ponds. This deliberate separation not only streamlines the selection process but also minimizes instances of spontaneous and undesired spawning among the broodstock, a strategy supported by Ramadhan and Sari [6].

As indicated in the literature, disparities among broodstocks can be attributed to various factors, including: 1) dissimilar genetic origins or genetic resources developed within distinct geographical regions, 2) variations in rearing environments across the development areas of each strain, and 3) the specific cultivation systems, encompassing maintenance media, containers, and feeding practices, which also play a significant role in shaping the characteristics of a particular strain.

Feeding regimes for these parent fish are carefully structured, comprising two daily feedings. These feedings are administered in the morning at 07:30 Western Indonesian Time (WIT) and in the afternoon at 15:00 WIT (as illustrated in Fig. 1). The dietary regimen for broodstock common carp involves LA-7 K-3 brand feed pellets, boasting a pellet size of 3mm, designed as floating pellets for easy access. The daily feed allocation is meticulously calculated at 2% of the total biomass of the broodstock. A detailed of the nutritional composition of the feed can be found in Table 1.

Table 1. Broodstock feed nutritional content

Nutrients	Content (%)
Protein	32
Fat	7
Crude Fibre	5
Ash	11
Moisture	11

3.2 Fish Spawning

3.2.1 Spawning media preparation

The spawning broodstock are placed in a hapa measuring 5 m x 4 m x 1 m, positioned within a concrete pond measuring 20 m x 15 m x 1.5 m, with a water level of 50 cm. To prepare the spawning pond, the entire pond surface is meticulously cleaned by scrubbing away adhering debris using a rubber mop (*slaber*). This is followed by a thorough rinsing with flowing water, gradually pushing out the dirt through the outlet pipe. Subsequently, the pond is filled with water, and a *hapa* measuring 5 m x 4 m x 1 m is installed to facilitate the harvesting and placement of the eggs (see Fig. 2).

Fig. 1. Feeding broodstock process

Fig. 2. Fish spawning container

3.2.2 Nursery pond setup

The nursery pond, measuring 24 m x 20 m x 1 m, is an earthen pond lined with HDPE plastic. Prior to stocking the larvae, preparations are made. This begins with a pond cleaning regimen, followed by pond drying, which serves the dual purpose of eliminating bacteria and pathogens. Next, a meticulous inspection of water channels, leaks, and seepages is conducted, followed by the application of a liming agent at a rate of 50 g/m^2. After liming, the pond is filled with water. Once filled, organic fertilizer is applied at a rate of 500 g/m^2 (see Fig. 3). According to Hasibuan et al. [7], pond drying typically lasts 5-7 days. Surface cracks in the pond soil indicate sufficient aeration, facilitating organic matter decomposition. This drying process effectively expels organisms residing in soil fissures, ensuring pathogen-free conditions. Additionally, it aids in the release of trapped toxic gases from the pond's bottom.

Fig. 3. Pond fertilization process

3.2.3 Broodstock selection

The selection of broodstock involves choosing sexually mature individuals with mature gonads ready for spawning. Key criteria for parental selection include sexual maturity, indicated by sperm production in males and mature egg production in females, and physical maturity, indicating readiness for productive parenthood. The quality and quantity of larvae produced during spawning significantly depend on the selection of suitable parents. The BBPBAT Sukabumi SOP guidelines for the selection of robust common carp broodstock are detailed in Table 2.

Table 2. Broodstock selection

Characteristics	Male	Female
Age	8 months	18 months
Length	22 cm	35 cm
Weight	500 grams	2000 grams

3.2.4 Spawning

Spawning in common carp occurs naturally, adhering to the recommended 1:1 male-female biomass weight ratio and a 1:4-5 male-female number ratio. In this instance, a 2:1 spawning ratio was employed, utilizing 60 male broodstock and 30 female spawners. The female parent is introduced first, followed by the male parent into the hapa. The use of a *hapa* during spawning simplifies egg harvesting and placement. Subsequently, the *kakaban* is positioned within the *hapa*, serving as a solid substrate for carp eggs to attach and as a protective cover to minimize disturbances during the spawning process. The spawning *kakaban* for common carp measures 1.2 m x 0.4 m, and a total of 100 *kakaban* units are neatly arranged to envelop the entire surface of the spawning container (see Fig. 4).

Carp possess an oviparous reproductive system, signifying that they engage in sexual reproduction. This process involves the external release of male and female gametes, or egg and sperm cells, with fertilization occurring externally as well. The common carp naturally spawns through external fertilization, whereby fertilized eggs adhere to aquatic substrates or plants within the water. In carp hatcheries, reproduction can be conducted organically, semi-artificially, or entirely artificially by utilizing spawning-promoting hormones. In natural spawning, mature male and female fish are paired in dedicated spawning tanks, maintaining a male-to-female ratio ranging from 2:1 to 3:1.

Fig. 4. Kakaban arrangement for spawning

According to Ismail and Khumaidi [8], common carp typically spawn from 22:00 Western Indonesian time until just before dawn, characterized by male parents pursuing females. The female parent releases eggs onto the *kakaban* before midnight, followed by the male parent releasing a white sperm fluid.

3.2.5 Fertilization rate and hatching rate

In accordance with the Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number KEP.24/MEN/2015, “Mantap” carp exhibit fecundity values ranging from 85,000 to 125,000 eggs/kg of parent fish and egg diameters ranging from 0.9 to 1.1 mm. Subsequently, the total number of fertilized eggs is calculated to determine the fertilization rate. Throughout the hatching process, fertilized and unfertilized eggs can be distinguished visually. Fertilized eggs appear clear, while unfertilized eggs have a milky white appearance. To ascertain the fertilization rate, deduct the total number of unfertilized sample eggs from the initial count of sample eggs. During the incubation phase, each egg was individually situated and exhibited a notably adhesive nature. This stickiness resulted in the attachment of a substantial amount of detritus to the egg's protective capsule. The egg capsule displayed a translucent, yellowish-white appearance, while the yolk appeared pale yellow or green and possessed a granulated texture. As development advanced, the eggs gradually became more translucent. The fertilized egg capsule measured between 0.8 to 1.0 mm in diameter, with the yolk sphere having a diameter ranging from 0.6 to 0.8 mm. The values for Fertilization Rate are detailed in Table 3.

Table 3. Fertilization rate

Number of sample eggs	Number of fertilized eggs	FR (%)
389	322	82,77

Based on Table 3, out of the total sample of 389 eggs, 322 eggs were successfully fertilized, yielding a commendable fertilization rate of 82.77%. This rate is considered notably high, aligning with Fani et al. [9], which state that any percentage of fish egg fertilization exceeding 50% is deemed high, while rates ranging from 30% to 50% are considered medium, and those falling below 30% are categorized as low. As emphasized by Keshavanath et al. [10], the degree of egg fertilization is subject to various factors, including egg quality, quality of fish sperm, and water conditions, particularly temperature and turbidity. In the context of these results, the predominant factor influencing the high degree of egg fertilization is believed to be the superior quality of the eggs produced by the female, which were evidently fully matured, thereby facilitating successful fertilization [11].

Following fertilization, the fertilized eggs were left for a duration of 24-36 hours with continuous aeration. The degree of egg hatching was assessed once the eggs had uniformly hatched. The precise calculation of the hatching rate was conducted using sample eggs within the coconut milk filter. Detailed hatching rate values are presented in Table 4.

Based on Table 4, out of the total 322 fertilized eggs, only 318 eggs successfully hatched, resulting in a hatching rate of 68%. This value appears relatively lower when compared to the findings of Fajarwati and Andriani [12], who reported a higher hatching rate of 81.98%. The hatchability of eggs can be influenced by various factors, encompassing both internal and external elements. Internal factors involve egg quality and sperm nutrition, while external factors encompass parameters such as dissolved oxygen (DO), pH, temperature, and ammonia levels. The success of achieving high egg hatchability hinges significantly on the interplay between egg quality, water quality, and precise handling during the hatching process [13]. Notably, [14] have indicated that the hatching period for common carp eggs typically spans 36-48 hours, generally ranging from 2 to 3 days from the point of fertilization. Based on research findings, fecundity is notably high in several carp strains. For instance, Majalaya carp exhibits a fecundity ranging from 84,000 to 110,000 eggs per kilogram of broodstock. Similarly, Sinyonya carp demonstrates a fecundity between 85,000 and 125,000 eggs, each with a diameter spanning from 0.3 to 1.5 mm. In contrast, steady carp has the capacity to produce a substantial number of larvae, amounting to approximately 140,000 fry.

Table 4. Hatching rate values

Number of sample eggs	Number of hatched eggs	HR (%)
318	389/218	68

3.2.6 Harvesting larvae

Larvae harvesting constitutes the subsequent step following the transport of the *kakaban.* This process involves gently collecting the larvae while moving around the perimeter of the pond, as illustrated in Fig. 5. Subsequently, the harvested larvae are temporarily placed in *jolang* bucket containers before being transferred to the *hapa.* This procedure continues until all the larvae have been successfully harvested. Once all the larvae have been collected, they are relocated to the nursery pond.

3.3 Nursery

The nursery phase represents the range from spawning through the rearing of larvae to the production of seeds. Nursery I, in particular, extended for a duration of 24 days within ponds Blocks A8, A12, A16, and BM1. Before the larvae were transported to the nursery pond, they were initially counted using a 100 ml measuring cup, after which they were placed in plastic packing bags for transportation. Upon arriving at the nursery pond, the larvae were gently dispersed into the water, as depicted in Fig. 6. This process incorporates an acclimatization step to ensure that the larvae can adapt seamlessly to their new environment, reducing stress levels. Each plastic bag accommodated 4 measures, with one measure containing 25,000 carp larvae. In total, 600,000 larvae were distributed across four nursery ponds, namely pond blocks A8, A12, A16, and BM1, at a stocking density of 300 fish/m².

Floating fine food is introduced after the larvae have been in the nursery pond for a period exceeding 3 days. This delay is because the nursery pond initially provides natural food resulting from the earlier fertilization. Specifically, floating fine feed of *the Feng-Li 0* brand is administered twice daily, at 07.30 and 15.00 Western Indonesia Time. The nutritional content of the provided feed is detailed in Table 5.

Fig. 5. Larvae harvesting stage

Fig. 6. Larvae distribution

To provide food in the nursery pond effectively, a technique involves encircling the pond in the direction of the wind while dispersing the feed. This method ensures that the food is evenly distributed throughout the pond and minimizes wastage (Fig. 7). Throughout the 24-day maintenance period, each nursery pond consumed an average of 33 kg of fine feed. This amount equated to 20% of the biomass, reflecting the protein requirement of common carp fry, which exceeds 30% [15].

Table 5. Nutritional content of larval feed

Nutrients	Content (%)
Protein	40
Fat	7
Crude Fibre	3
Ash	13
Moisture	10

Fig. 7. Larvae feeding process

3.3.1 Length growth

As per various studies, growth in fish is characterized by their progressive increase in both weight and length over time. This phenomenon is primarily governed by two key factors. The first set of factors pertains to internal considerations, encompassing aspects like the fish's innate disease resistance and genetic makeup. The second category includes external elements such as environmental conditions in the fish's habitat and the accessibility of food resources. Based on the observations conducted approximately every seven days over the 24-day maintenance period, with a sample of 30 fish per measurement. Growth, a crucial aspect of development, refers to the progressive increase in an organism's length and weight within a specific time frame. The growth of fish is influenced by multiple factors, including the quality and quantity of food, age, and water quality. The graph above reveals that during the first week of sampling in Nursery Phase I, the average total length of common carp fry was 1.58 cm, followed by 1.75 cm in the second week, 1.88 cm in the third week, and 2.36 cm in the fourth week, resulting in an absolute length growth of 0.78 cm. In comparison, research by Ridwantara et al. [16] reported an absolute growth of 2.59 cm for common carp. Additionally, studies involving common carp fry subjected to various biofilter treatments demonstrated growth ranging from 1.09 to 1.30 cm [17]. Non-uniform growth in size and weight among the fry or fingerlings may be attributed to high stocking densities, which lead to competition for food and insufficient food quantities. Moreover, variations in growth can be linked to water quality, particularly temperature, which affects feeding behavior since fish appetite is influenced by optimal temperature conditions [18].

Fig. 8. Carp fry length measurement process

3.3.2 Weight growth

The assessment of weight growth, based on observations conducted approximately every seven days over the 24-day maintenance period with a sample of 30 fish per measurement. Growth in fish encompasses changes in size, weight, and volume over a defined period and results from tissue alterations arising from cell division, particularly within muscle and bone cells, which constitute the majority of a fish's body mass. The provided graph indicates that during the first week of sampling in Nursery Phase I, the average total weight of common carp fry was 0.08 grams. Subsequently, in the second week, it increased to 0.09 grams, followed by 0.14 grams in the third week, and 0.19 grams in the fourth week, resulting in an absolute weight growth of 0.11 grams. This increase in fry body weight can be attributed to the protein content of the provided feed ingredients. The protein content in the diet plays a pivotal role in tissue formation for growth and the replacement of damaged tissue. Insufficient protein can negatively affect feed consumption, resulting in reduced weight gain. Conversely, excessive protein and fat can lead to fat accumulation, diminishing fish appetite [19]. For reference, research by Sabrina et al. [17] reported common carp cultured with various biofilter media achieved absolute growth ranging from 1.28 to 1.78 grams. Meanwhile, a study by Ridwantara et al. [16] revealed that carp fry reared at different temperature ranges exhibited absolute growth spanning 1.02 to 4.38 grams. The energy derived from the feed serves to fulfill the fish's various metabolic requirements. Chief among these is the basal energy requirement, which is essential for their basic survival. Once these fundamental energy needs are satisfied, any surplus energy becomes available for addressing other demands, including reproductive development, bolstering disease resistance, fortifying against environmental stresses, and supporting growth.

Fig. 9. Fry weight measurement process

3.3.3 Fry harvesting

The process of harvesting is initiated after the 24-day maintenance period. It involves closing the inlet channel and draining the pond through the outlet pipe, with *hapa* used to prevent fry from escaping (Fig. 10). Pond drainage is conducted in the morning to ensure that harvesting is performed without undue stress on the fry. Once the water has receded, larvae are collected within the pond using a waring tool, and subsequently, a fine aluminum blade is employed to remove them. The collected fry are then placed in a bucket filled with water before being stored in a suitable container. The sheltered fry undergo a sorting process to ensure uniformity in size among the fish.

3.3.4 Survival Rate (SR)

The survival rate (SR) of common carp is determined as the percentage of live fish at the end of the study compared to the number of fish at the start of rearing. After approximately 25 days of nursery maintenance I, the obtained survival rate is presented in Table 6.

From Table 6, it's evident that the initial stocking consisted of 200,000 common carp, while the final count after rearing was 103,000 common carp, resulting in a SR of 51.5%. This value, while indicative of a considerable number of surviving common carp, falls short of the standards set by (Indonesian National Standard) SNI 01-6132-1999 [20], which considers an SR exceeding 60% as 'Well.' The relatively lower survival rate in this study is believed to be influenced by less-than-optimal water quality during maintenance, coupled with a lack of pest and disease control measures. It's worth noting that diseases often correlate with water quality; hence, maintaining good water quality can significantly reduce the risk of disease outbreaks and improve common carp survival [18]. For comparison, a study by Fajarwati and Andriani [12] reported an SR of 70.07%. Similarly, research by Sabrina et al. [17] investigating common carp growth using various biofilters found SR values for common carp fry ranging from 50-70%. Nevertheless, it's important to mention that these results are below those in another study [21], which indicated an SR of 87.23% for common carp fry fed natural food. According to the literature, both abiotic and biotic factors play pivotal roles in determining high and low survival rates. These factors encompass aspects like competition, population density, the age of organisms, and their adaptability to their surroundings. Furthermore, employing superior breeding stock, known for their high survival rates, can significantly boost productivity and yield more favorable economic returns compared to using local seed sources.

Fig. 10. Fry harvesting process

Table 6. Survival rate value

Initial Number of Stocking	Final Number of Nursing Phase	SR (%)
200,000	103,000	51,5

3.3.5 Water quality

To assess the management of nursery pond water quality for common carp, we measured various parameters, including alkalinity, temperature, pH, dissolved oxygen (DO), CO_2, NH_4^+, and NO_2. Water samples were collected directly from the maintenance pond and placed into sample bottles. Subsequent water quality analysis was performed by laboratory assistants at the Sukabumi BBPBAT Water Quality Laboratory, and the results are presented in Table 7.

Table 7. Nursery pond water quality

Parameters	Value
Temperature	24°C
pH	6.87
DO	2.74 mg/l
NH_4^+	1.1 mg/l
NO_2	0.06
CO_2	63.82 mg/l
Alkalinity	83.42 mg/l

Table 7 reveals that the temperature in the maintenance pond was 24°C, the pH level was 6.87, and the dissolved oxygen (DO) concentration was 2.74 mg/l. In accordance with SNI: 01-6137-1999 (Indonesian National Standard) [22], the recommended water quality parameters for rearing common carp fry are a temperature of 28°C, a pH range of 6.5–8.5, and a minimum DO level of 5 mg/L. It's notable that the temperature and DO levels in the common carp rearing pond did not meet these optimum values, although the pH was within the acceptable range for maintenance. In a related study by Sulawesty et al. [23] on common carp rearing in closed flow ponds, temperature ranged from 23–30°C, pH values were recorded between 6.81–7.87, and dissolved oxygen concentrations varied from 2.5–7.1 mg/l. Additional research indicates water quality parameters in *Najawa* carp seed rearing ponds: temperature in the range of 26.6–30.5°C; pH levels between 7.1–7.36; and dissolved oxygen concentrations ranging from 6.23–10.8 mg/L [6].

Adequate oxygen is vital for the growth of common carp as it is a key requirement for their metabolic processes. Oxygen deficiency induces stress in the fish by depriving the brain of this essential element, and the most severe consequence could be death, as it disrupts their respiratory process. Insufficient levels of dissolved oxygen can be fatal to fish, as it is indispensable for their metabolic functions, facilitating the breakdown of food to generate the energy necessary for their growth.

The NO_2 concentration measured 0.06, aligning with Class 2 water quality standards for cultivating freshwater fish; this indicates a nitrite content of 0.06 mg/l. Sihite et al. [24] also classified nitrite levels of 0.001 mg/l as suitable for common carp rearing. Furthermore, the CO_2 value was 63.82 mg/l, and the alkalinity value measured at 83.42 mg/l. As mentioned by Hidayat and Yulisma [25], external factors, encompassing physical, chemical, and biological properties of water, play a crucial role in common carp growth.

In most cases, oxygen transfer through diffusion plays a crucial role in making oxygen from the water column accessible to the underlying soil. Nevertheless, this method tends to be slow and often inadequate, particularly in natural feed-dependent aquaculture setups. Conversely, when common carp engage in resuspension activities, they enhance aerobic decomposition within the sediment by boosting the oxygen levels in the lower soil. Consequently, this expedites the breakdown of organic matter within the sediment [26].

4. CONCLUSION

The spawning results yielded a commendable fertilization rate of 82.77% and a hatching rate of 68%. Consequently, 600,000 larvae were obtained and subsequently transferred to a nursery pond, where they were reared for 24 days, resulting in a survival rate of 51.5%. Furthermore, the study revealed an absolute length increase of 0.78 cm and an absolute weight increase of 0.11 grams in the common carp fry. Based on the observations and findings from the hatching process of common carp at BBPBAT Sukabumi, it is advisable to avoid hatching eggs in an outdoor pond. Instead, it is recommended to employ a hatchery or utilize an egg hatching tank equipped with a heater. This recommendation is especially pertinent considering the relatively low temperatures typically experienced in the BBPBAT Sukabumi region.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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