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Natural Spawning Breeding Techniques Analysis of Carp (*Cyprinus carpio*) in the Fish Seed Center (BBI) Bolangan, Tabanan, Bali

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Abstract

Carp (*Cyprinus carpio*) is a freshwater fish species with a high tolerance to various environmental conditions. The present study aimed to analyze the carp's seeding process using a natural spawning method at the Fish Seed Center (BBI) Bolangan, Tabanan, Bali. The descriptive analysis was used to analyze the data collected through active participation, observation, and interviews. The carp natural spawning techniques at BBI Bolangan were conducted in an earthen pond. The breeding techniques include pond preparation, brood stock selections, fish spawning, larvae or seed maintenance, water quality control, disease control, and fish harvesting. Male and female broodstocks in a 2:1 ratio were required for effective breeding. This natural hatching system produced up to 100806 eggs with a hatching rate of 74.4%, yielding 75000 larvae per female broodstock. After a week of care, the larvae have a 30% survival rate and are ready for cultivation in the following section (nursery II). We conclude that the Carp (*C. carpio*) breeding techniques at the Fish Seed Center (BBI) Bolangan, Tabanan, Bali, are technically sound and feasible to apply.

INTRODUCTION

The carp (*Cyprinus carpio*) is one of the important fish species for the aquaculture industry in the world. It is a fatty aquatic animal from the Cyprinidae family, a vast group of fish endemic to Europe and Asia with a high content of water, protein, fat, minerals, and vitamins essential for human health (Damongilala, 2021). The cultivation of this fish in sub-tropical countries requires very controlled conditions with hormonal stimulation in females due to the asynchronous natural spawning (Brzuska, 2021). Carp spawning can occur naturally without hormonal induction if environmental conditions resemble their natural habitat conditions (Mustamin *et al*., 2018). Artificial spawning can be accomplished by administering a hormone to hasten spawning (Yuatiati and Nurhayati, 2015). In Indonesia, several carp fry supply units that apply hatchery techniques are BBI Tenggarang Bondowoso, UPT PBAT Umbulan Pasuruan, Lajoa Freshwater Fish Development Installation in Soppeng Regency, and BBI Cimaja Sukabumi (Ismail and Khumaidi, 2016; Ramadhan and Sari,

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2018; Lukman *et al*., 2021; Fajarwati and Andriani, 2022). Artificial spawning technique for carp utilizing ovaprim hormone has been used in Salupao Fish Seed Center, Maroangin Village, Telluwanua District, Palopo City, South Sulawesi (Idrus, 2016), though natural spawning is still an option in most fish hatchery units.

The Fish Seed Center (BBI/Balai Benih Ikan) Bolangan is one of the Regional Technical Service Units (UPTD) engaged in carp hatchery in Bali. BBI Bolangan consistently develops carp hatcheries with a high success rate. This shows that carp hatcheries' skills, knowledge, and skills have been well mastered in this station (Ilhamdi *et al*., 2020). This study aims to analyze the carp's seeding process using a natural spawning method at the Fish Seed Center (BBI) Bolangan and identify factors supporting the success of natural hatchery carp. Analysis of carp hatcheries includes hatchery techniques, broodstock selection, reproductive performance, and water quality. The hatchery methods carried out at BBI Bolangan were analyzed by comparing the standards (SNI 8035,2014; SNI 01-6130-1999; SNI 01-6133-1999). This comparison is to find out the implementation of standards that have been applied to the carp hatchery process at BBI Bolangan.

METHODOLOGY

Ethical Approval

All studies in this work using carp (*C. carpio*) were conducted in accordance with the National Standardization Agency of Indonesia certification SNI 8035:2014. All of the authors state that this study was carried out in an ethical and responsible manner.

Place and Time

The research was carried out at the BBI Bolangan, Babahan Village, Penebel District, Tabanan Regency, Bali Province on June 6 - July 2, 2022. The BBI Bolangan is located at the coordinates of 111° S and 6° 30' E (Figure 1).

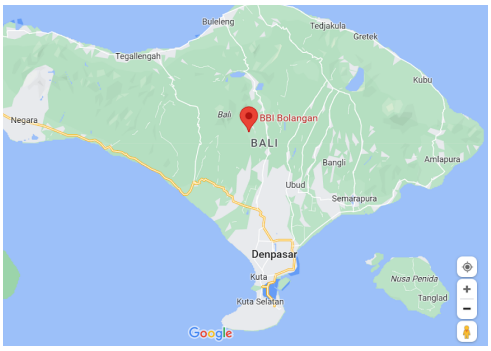

Figure 1. The BBI Bolangan is located at the coordinates of 111° S and 6° 30' E in Bali Island, Indonesia.

Research Materials

The Majalaya strain of crap was used from Majalaya, West Java. The ratio of the number of male and female broodstocks spawned is 2:1. The male fish is eight months old and has a body weight of about 500 gr. The female fish is 18-24 months old and has a body weight of about 2000 gr.

Research Design

The research was carried out using a case study approach through discussion and following the entire series of hatchery activities at BBI Bolangan. The method used in this study is observation, with primary data collection, interviews, and literature studies as secondary data. Researchers directly worked on seeding techniques with BBI Bolangan technicians to obtain primary data. They interviewed a technician while collecting primary data about carp hatchery facilities and infrastructure at BBI Bolangan. Primary data included spawning pond preparation techniques, characteristics of the

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broodstock spawned, reproductive performance, water quality, pest and disease control, growth of fish larvae, and harvest of fish seeds. The data obtained was compared with the Indonesian National Standards for carp hatcheries.

Work Procedure

Carp breeding and hatchery techniques were observed daily, including feed and water quality management. The newly hatched larvae are not immediately fed because they still have egg yolk reserves. Larvae that are 2-3 days old are fed with one boiled egg yolk crushed in 1 liter of water and then spread evenly in the larval-rearing pond. The next feeding method is blind feeding, with an amount of 20 grams of powder feed given twice a day.

Water quality is maintained by flow through the system. Water quality in pH and dissolved oxygen content is observed daily. Monitoring the condition of the larvae includes the increase in the larvae's size and weight, which are measured every week. Hatchery activities use male and female carp (carp) reared in broodstock tanks and transferred to hatcheries during spawning.

Data Analysis

All data obtained were analyzed descriptively by comparison with references from journals and fish hatchery standards (SNI 8035:2014) and carp hatchery standards (Majalaya strain) (SNI 01-6130-1999 and SNI 01-6133-1999).

RESULTS AND DISCUSSIONS

Spawning Pond Preparation

The spawning pond construction at BBI Bolangan was rectangular, with concrete ripens and a soil pond bottom. The size of the pool is 25x23x1 m. The pond is equipped with an inlet, an outlet, a channel for pond water disposal, and a fish fry harvesting site (Figure 2). This construction complies with the SNI 01-6133-1999 standard.

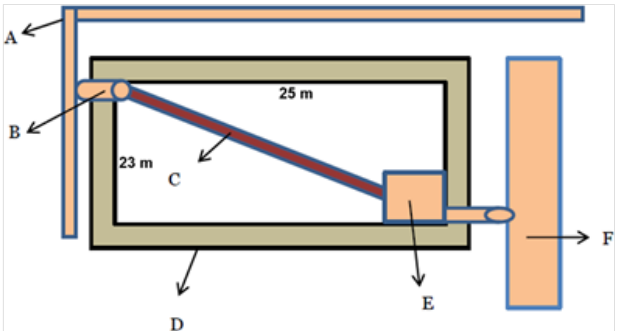

Figure 2. Construction design of carp spawning ponds.
Description: (A) Water channel into the pond; (B) Inlet hole; (C) Pool bottom puddle; (D) Pond ripens; (E) Outlet hole; (F) Sewerage and fish fry harvesting site.

Good pond care for the cultivation process can be done by drying the pond, plowing the pond bottom soil, liming the soil, fertilizing the soil, and flooding the pond soil (Hasibuan *et al*., 2021). The pond preparation process at BBI Bolangan begins with drying the bottom of the ground pool for 3-7 days. The next basic process of soil processing is plowing using a tractor. Soil plowing has benefits in that the soil is not porous, can hold water, and is more hygienic (Ismail and Khumaidi, 2016). After the soil is plowed and mixed evenly, the pool bottom puddle-making begins from the inlet to the outlet (Figure 3). The manufacture of pool bottom puddles is also intended as a gathering place for a fish fry at the time of harvesting.

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Figure 3. Pond preparation activity of carp breeding technique in BBI Bolangan, Tabanan, Bali.
Description: (1) plowing of the land and (2) manufacture of pool bottom puddle.

The next stage is the filling of water about 60 cm from a pool depth of 100 cm, and then the water is allowed to stand for three days so that plankton can grow properly. In addition to water preparation, kakaban preparation is also carried out, which serves as a place to attach carp eggs. Kakaban is made with a length of 1-2 m and a width of 40 cm (Figure 4). The kakaban needed for carp spawning depends on the weight and number of broods. Kakaban measuring 100x40 cm is needed as much as 5-6 kakaban per kg of carp brood. A carp brood weighing 5 kg requires 25-30 kakaban.

Figure 4. Installation of happa and kakaban activity of carp breeding technique in BBI Bolangan, Tabanan, Bali.
Description: (1) Happa and (2) Kakaban.

Broodstock Selection

The selection of prospective carp broodstock is vital to produce quality fry. The type of carp broodstock used was the Majalaya strain. Healthy male and female carp with no broodstock morphological disorder or disease were selected. Prospective broodstocks were selected based on the characteristics of the age of more than 1.5-2 years with a minimum weight of 2 kg per fish for female broodstocks. Meanwhile, male broodstock fish should be over eight months old with a minimum weight of 0.5 kg per fish.

This brood selection was similar to the national standards (SNI 01-6133-1999) and almost the same as previously reported methods (Prakosa and Ratnayu, 2016). The selected prospective broodstocks have the characteristics of a smooth body, not deformed, undamaged fins, clean gills with no white spots, eyes that appear clear, scales on both sides of the body are symmetrical there are no grooves and fractures, bright scale color (Figure 5).

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Figure 5. Selection of carp brood activity of carp breeding technique in BBI Bolangan, Tabanan, Bali.
Description: (1) male and (2) female.

Carp Spawning

Carp spawning at BBI Bolangan is carried out naturally, namely mating male and female broodstocks in one pond without pituitary hormone injection treatment. This spawning method complies with the national SNI 01-6133-1999 standard. Different spawning techniques determine seed production performance (Kurniaji *et al*., 2022). The choice of spawning method is natural because carp are fish that are easy to spawn. The ratio of male to female broods introduced into the spawning pond is 2:1. The comparison of the number of male and female broodstocks can also use a ratio of 5:1 (Fajarwati and Andriani, 2022). The release of the brood is carried out in the afternoon around 16.00-17.00 WITA. The spawning process occurs in the early morning, around 01.00-06.00 WITA, characterized by fish chasing each other and a fishy smell wafting from the pond water.

Carp spawning can occur at 22.00-03.00 WIB (Evangelista and Junianto, 2021). Spawning can be optimal at a temperature of 26ºC at a pond water pH of 7.5 (Sapkale *et al*., 2011). In addition to environmental factors, the spawning of Cyprinus carpio fish is also influenced by the optimal natural mating season in February-April (Tessema *et al*., 2020). After 24-36 hours since the brood was released into the spawning pond, fish eggs attached to the kakaban were observed (Figure 5). Carp hatchery performance data at BBI Bolangan generally meet the criteria for carp hatchery national standards (Table 1).

Figure 6. Carp spawning activity of carp breeding technique in BBI Bolangan, Tabanan, Bali.
Description: (1) release of brood into ponds and (2) observation of eggs.

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Table 1. Summary of carp breeding performance in BBI Bolangan and reference.

Parameter	BBI Bolangan	Reference
Broodstock ratio	Male: female (2:1)	Male: female (2:1)*
Age of the male brood first maturing gonads (months)	8	8*
Age of the female brood first maturing gonads (months)	18-24	18*
The body weight of the male brood first matures gonads (grams/individual)	500	500*
The body weight of the female brood first matures gonads (grams/individual)	Min. 2000	2500*
Fecundity (eggs/kg)	100806	85000-125000*
Hatching rate (%)	74.4	94**
Larvae survival rate (%)	30	60-80*
Larvae Size (cm)	1-3	1-3*

*(SNI 01-6133-1999); ** Ed-Idoko *et al*. (2021).

Carp Egg Hatching

Spawning ponds are equipped with happa as a place to hatch eggs. Happa is made of fine nets measuring 1 mm or smaller than the size of eggs laid in the pond. Happa serves to prevent pests from entering the pond and prevent eggs from being eaten by snail pests. Hatching of eggs lasts between 24-36 hours. The eggs will hatch into larvae, while the eggs that do not hatch will be white. The causes of eggs not hatching include incomplete fertilization. The number of eggs hatched into larvae is estimated at 75000 larvae with a Hatching Rate (HR) value of 74.4%. Dash *et al*. (2018) reported the results of artificial spawning in Cyprinus carpio with three different types of hormones, namely Gonopro-FH (HR 80%), Ovatide (HR 69%), and Wova-FH (HR 45%).

The HR value generated from natural spawning techniques in BBI Bolangan is still quite good when compared to artificial spawning techniques using Ovatide and Wova-FH hormones. Based on the research results by Ed-Idoko *et al*. (2021), the spawning process using artificial techniques in indoor concrete ponds resulted in a higher HR value of 94%. Due to environmental factors, carp eggs at BBI Bolangan cannot hatch 100%. One factor that can increase carp's degree of survival is temperature. The optimum temperature for hatching eggs is 32°C (Muslim and Atjo, 2021). Other factors that affect the hatching of fish eggs are bacteria or Saprolegnia fungal attacks that can inhibit egg hatching (Yahya *et al*., 2014; Diana *et al*., 2017). Increasing the hatchability of carp eggs attacked by fungi can be done by utilizing basil leaf extract at a dose of 65 mg/l (Rukka *et al*., 2022).

After the eggs hatch into larvae, they are not immediately fed because they still have food reserves in the yolk. After the larval food reserves run out, the larvae rely on natural feed in the form of plankton in the pond. Maintenance in hatchery ponds lasts until the larvae are one week old and the size of carp larvae reaches 1-2 cm. Larvae are seven days old and can be given artificial feed every morning in fine pellets of as much as 200-300 grams /pond (Septihandoko and Lamid, 2020). A good type of artificial feed for carp larvae has a protein content of 60% (Supriyanto and Dharmawanto, 2018). However, the maintenance of fish larvae at BBI Bolangan relies on natural feed in the pond, and artificial feed is added.

Rearing Carp Larvae

Treatment of carp larvae carried out at BBI Bolangan is fertilization in ponds. The fertilizer used is manure containing chicken manure with a dose of as much as 10 kg. The fertilizer is packed in sacks and given a small hole on the surface of the sack. This larvae-rearing method complies with the national SNI 01-6133-1999 standard. Manure application can spur plankton growth as a natural feed for fish larvae (Kusrini *et al*., 2015). After the brood is returned to the brood-rearing pond, the manure application

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is carried out. The color of the pond water becomes greenish due to the growth of phytoplankton as natural feed for fish larvae. The maintenance of *C. carpio* larvae in soil ponds overgrown with phytoplankton will be better when compared to maintenance with a recirculation system in plastic ponds (Mojer *et al*., 2021). The water level in the nursery pool is maintained at a range of 30 cm by regulating the discharge of water entering the pool. The growth of the length and weight of fish larvae is measured once a week. The results of carp fry sampling obtained an increase in length of 0.18 cm and weight of 0.02 grams per week.

Water Quality Monitoring

The water used as a medium for rearing brood, larvae, and carp fry at BBI Bolangan comes from Sidem and Soka springs, which flow directly into the pond through waterways. Water management in the inlet has a filter basin that filters dirt and garbage carried by water currents. Water quality checks include temperature and DO, which are carried out daily in the morning and evening. The water quality parameters comply with the national SNI 01-6133-1999 standard (Table 2). The average temperature in the morning is 21.8°C, while in the afternoon it is 24.5°C.

According to Goran *et al*. (2016), the temperature range of 21-26°C is still good enough for the growth and development of carp larvae. The optimum temperature for a carp hatchery is 26°C (Sapkale *et al*., 2011). The result of measuring the pH of the water is 7-8.5. The optimal pH in larval rearing ponds ranges from 6.5-8.5 (SNI 01-6133-1999). The results of DO measurements in the morning were 2.97 mg/l, while in the afternoon it was 4.39 mg/l. The pool's DO value was quite low compared to the results of other studies, namely, DO ranged from 5-8 mg/l (Shaheen *et al*., 2011; Malik *et al*., 2018).

Table 2. Summary of water quality in BBI Bolangan and reference.

Parameter	BBI Bolangan	Reference
Latitute (MASL)	570	0-1000 (SNI 01-6133-1999)
Temperature (°C)	21.8-24.5	25-30 (SNI 01-6133-1999)
pH	7.5-8.0	6.5-8.5 (SNI 01-6133-1999)
Dissolved oxygen (mg/l)	2.97-4.39	Minimum 5(SNI 01-6133-1999)
Water quality management	Flow through	Flow through (SNI 01-6133-1999)
Water level (cm)	50	50-70 (SNI 01-6133-1999)

Pest and Disease Control

Pests often found in larval-rearing ponds are frogs, birds, snails, and crabs. Pest control is carried out by catching frog broods, not to lay eggs in larval-rearing ponds. Bird pests that can prey on fish larvae can be prevented by installing ropes around the pond and cutting tree branches where birds perch around the pond. Snails can eat carp eggs, and crabs can hollow out pond ripens. Pests such as snails and crabs are eradicated by catching and throwing them away from ponds. Parasites, bacteria, and viruses can cause diseases affecting carp. Ectoparasites that can attack carp include *Argulus* sp., which causes argulosis (Nurani *et al*., 2020).

Control of argulosis can be done by using synthetic insecticides, drying ponds, and water filtration (Farizqi and Nugroho, 2021). Another parasite that can cause disease in carp is *Gyrodactylus* sp. and *Dactylogyrus* sp. (Bandu *et al*., 2022). Types of pathogenic bacteria that harm carp include *Aeromonas* sp., *Pseudomonas* sp., and *Erdwardsiella* sp. (Pardamean *et al*., 2021). The virus that can attack carp is Koi Herpes Virus (KHV), which can cause death (Sultan *et al*., 2018). Efforts are made at BBI Bolangan to prevent disease by applying biosecurity during the seeding process.

Carp Fry Harvesting

Harvesting carp fry at BBI Bolangan begins with installing a filter at the outlet

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and lowering the water to 30 cm a day before harvesting. The harvesting process is carried out in the morning starting at 07.00 WITA. During the process of reducing the amount of water, happa is also installed near the harvesting pond, which aims to accommodate fish fry for easy transfer. Fish fry and mud that have entered the reservoir are cleaned in the reservoir. Harvesting is done by total harvesting, simultaneously by drying the pond. Carp fry harvested were 22830 heads with a Survival Rate (SR) value of 30.44%.

The SR value in this hatchery is low. Low SR of carp fry can be caused by not disinfecting the pond to reduce pathogens such as bacteria or fungi that are harmful to fish larvae. The disinfection process increases the HR and SR of carp fry up to 95%, and methylene blue one mg/l can be used (Yeasmin *et al*., 2015). Harvested seeds are 1-3 cm in size. Carp fry that has been harvested is transferred to holding ponds and feeding ponds. Carp fry is satisfied for about 2-6 hours to reduce dirt on fish. Packaging carp fry measuring 1-3 cm using double plastic bags with 1000-2000 heads per plastic bag. The ratio of water and oxygen in each plastic bag is 1: 2. The price of carp fry measuring 1-3 cm is Rp 20.00/fry. These carp fry harvesting methods and production comply with the national SNI 01-6133-1999 standard.

CONCLUSION

Carp hatchery at BBI Bolangan is carried out naturally and consists of pond preparation, brood selection, spawning, larval rearing, water quality monitoring, harvesting, and packaging fish fry. Pond preparation includes drying, plowing, water topping up, and fertilizing to grow phytoplankton. The ratio of male and female spawned is 2: 1. The number of eggs that hatch into larvae is 75,000 with a Hatching Rate (HR) value of 74.4%. The number of seeds produced was 22,830 heads, with a Survival Rate (SR) value of 30.44%. Hence, the Carp (*Cyprinus carpio*) breeding techniques at BBI Bolangan, Tabanan, Bali, are technically sound and feasible to apply according to hatchery standards. Natural spawning is easy and can be developed by fish farmers to provide carp fry in Bali and surrounding areas.

CONFLICT OF INTEREST

The author declares no conflict of interest in writing the article.

AUTHOR CONTRIBUTION

Anik Kusmiatun: principal researcher, corresponding author, data analyst, and manuscript writer. I Made Putra Arsana: collecting data and writing the manuscript. Indah Istiqomah: Data analysis and manuscript writing.

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