Indonesian Journal of Aquaculture Medium

https://journal.unram.ac.id/index.php/jmai/index. E-ISSN : 2798-0553

VOLUME 3, NUMBER 4, NOVEMBER 2023

Evaluation and Management System for Koi Fish (*Cyprinus carpio*) Fingerlings Production at Omah Koi Farm Indonesia

Evaluasi Sistem dan Pengelolaan Produksi Benih Ikan Koi (*Cyprinus Carpio*) di Omah Koi Farm Indonesia

Agung Luthfi Fauzan[1*], Irzal Effendi[2]

[1]Aquaculture Science Study Program, Postgraduate School, IPB University, [2]Aquaculture Department, Faculty of Fisheries and Marine Sciences, IPB University

Bogor, West Java, 16680 Indonesia

[*]Coresponding author: agungluthfifauzan@apps.ipb.ac.id

ABSTRACT

Koi fish (*Cyprinus carpio*) is a freshwater ornamental fish commodity that has important economic potential, both nationally and internationally. Breeding is an activity in cultivation to produce seeds which are very decisive at the next stage of cultivation activities. The purpose of this study was to evaluate the system and management for koi fish seed production at Omah Koi Farm Indonesia. The test parameters measured were fecundity, fertilization rate (FR), hatching rate (HR), seed survival, seed quality, and water quality. The hatchery process includes pond preparation, parent selection, spawning, hatching eggs, rearing larvae, harvesting larvae, stocking larvae, feeding, feeding seeds, harvesting seeds, selecting seeds, and managing water quality. The results of the Kohaku and Showa fecundity calculations were 30,000 and 35,000 items respectively. The FR value obtained is 90,71% and HR is 82,93%. The average survival of koi seeds aged 45 days was 91,75% with an average of 150 high quality (HQ) seeds, 450 grade A seeds, and 450 grade B seeds. The temperature range in the larval rearing ponds was 25-27 0C, the water pH ranged from 7.9-8.5, DO ranged from 5.0-6.0, and ammonia was 0.01.

ABSTRAK

Ikan koi (*Cyprinus carpio*) merupakan salah satu komoditas ikan hias air tawar yang memiliki potensi ekonomis penting, baik secara nasional maupun international. Pembenihan merupakan suatu kegiatan dalam budidaya untuk menghasilkan benih yang sangat menentukan pada tahapan kegiatan budidaya selanjutnya. Tujuan dari penelitian ini adalah mengevaluasi sistem dan pengelolaan produksi benih ikan koi di Omah Koi Farm Indonesia. Parameter uji yang diukur yaitu fekunditas, *fertilization rate* (FR), *hatching rate* (HR), kelangsungan hidup benih, kualitas benih, dan kualitas air. Proses pembenihan meliputi persiapan kolam, seleksi induk, pemijahan, penetasan telur, pemeliharaan larva, pemanenan larva, penebaran larva, pemberian pakan, pemberian pakan benih, pemanenan benih, seleksi benih, dan pengelolaan kualitas air. Hasil penghitungan fekunditas Kohaku dan Showa masing-masing 30.000 butir dan 35.000

butir. Nilai FR yang didapatkan yaitu 90,71% dan HR sebesar 82,93%. Rata-rata kelangsungan hidup benih koi umur 45 hari 91,75% dengan rata-rata benih grade *high quality* (HQ) 150 ekor, grade A sebanyak 450 ekor, dan grade B sebanyak 450 ekor. Kisaran suhu pada kolam pemeliharaan larva 25-27 ^{0}C, pH air berkisar 7,9-8,5, DO berkisar 5,0-6,0, dan amonia sebesar 0,01.

Kata Kunci	*Ikan koi, Pembenihan, Kohaku, Showa*
Keywords	*Koi fish, Breeding, Kohaku, Showa*
Tracebility	Tanggal diterima : 12/10/2023. Tanggal dipublikasi : 4/11/2023
Panduan Kutipan (APPA 7th)	Fauzan, A. L. & Effendi, I. (2023). Evaluation and Management System for Koi Fish (*Cyprinus carpio*) Fingerlings Production at Omah Koi Farm Indonesia. *Indonesian Journal of Aquaculture Medium,* 3(4), 224-233. http://doi.org/10.29303/mediaakuakultur.v3i4.3636

INTRODUCTION

Koi fish (*Cyprinus carpio*) is a freshwater ornamental fish commodity that has important economic potential, both nationally and internationally. Currently, koi fish cultivation has been widely developed in Indonesia. Koi fish production in the third quarter of 2019 was 361,405 from the targeted production of 241,500 (DJPB 2019). The export value of koi fish in Indonesia continues to increase, namely in 2010 with an export value of around 12 million dollars, increasing to 20 million dollars in 2011 and the export value of koi fish continued to increase in 2016, reaching 65 million dollars. According to Ishaqi and Sari (2019), to produce quality koi fish, good cultivation management is needed so that good fish offspring or seeds will be produced. One important factor that influences the sustainability of koi fish cultivation is the availability of quality koi fish seeds. Several factors influence the growth of koi fish, namely the type of fish, genetic characteristics, ability to utilize feed, resistance to disease and supported by environmental factors such as water quality, feed and stocking density (Kifly et al. 2020).

Koi fish hatcheries are an important factor in supporting the sustainability of koi fish farming businesses. Seeding is an activity in cultivation to produce seeds which is very decisive for the next stage of cultivation activities. The need for quality koi fish seeds cannot be met because production is still limited. Therefore, a seeding technique is needed that is easy for koi fish farmers to apply, so that it can encourage the production of koi fish seeds, both in quantity and quality. A study of koi fish hatchery techniques using biological, environmental and intersectoral indicators can provide important information to realize the sustainability of environmentally friendly koi fish production. The aim of this research is to evaluate the system and management of koi fish seed production at Omah Koi Farm Indonesia.

RESEARCH METHODS

Good Fish Hatchery Methods

Koi fish farmers have implemented good fish hatchery methods (CPIB) in producing quality koi fish seeds, including technical, management, food safety and environmental requirements. CPIB standards are used to obtain certificates from the Directorate General of Aquaculture. CPIB is a seed quality management system in order to produce quality seeds that meet food safety and environmentally friendly requirements. Apart from the quantity of seeds having to be sufficient, the quality of the seeds is also one of the determining factors for the success of a cultivation business. In order to produce quality seeds, seeding activities must apply techniques according to good standards and

procedures. The CPIB reference used for the production of koi fish seeds is SNI 8296.1:2016 for the production of koi fish seeds and SNI 7869:2013 for artificial feed for koi fish.

Location, Facilities and Infrastructure for Hatcheries

Hatchery Location

Requirements for hatchery locations and water sources as intended are:

a. Built in a location that is protected from the possibility of flooding, erosion and contamination from industrial, agricultural, mining and residential waste
b. Have a water source that is suitable for the life and growth needs of the fish being kept and is available throughout the year
c. Easy to reach, available supporting facilities and infrastructure such as electricity networks, communication and transportation facilities
d. Legality aspects according to its intended purpose

Environmental requirements are:

a. Waste water from this production process before it reaches public waters or the surrounding environment must be treated first so that it becomes neutral again. Each hatchery unit must have a waste processing unit for organic materials, microorganisms and chemicals.
b. Sanitation of the hatchery environment is supported by the availability of adequate cleaning facilities, including: cleaning equipment, trash cans and toilets.

Facilities and infrastructure

a. Space: laboratory, machine room, feed storage area, chemical and drug storage area, equipment storage area, office or administration room
b. Tanks/containers: settling and/or filtration systems and/or reservoirs, quarantine, broodstock rearing, spawning and hatching, seed rearing, seed storage, live food culture, display ponds, and waste processing
c. Materials and equipment: production materials and equipment, harvesting materials and equipment, machine tools, laboratory equipment
d. Biosecurity facilities: fences, partitions between production units, footbaths, hand sanitizers and wheelbaths for clothing and personnel work equipment.

Koi Fish Seed Production Process

Koi Parent Management

Parent koi fish are reared in an earthen pond (Mudpond) measuring 5 x 10 m with a pond depth of 1.5 meters. Male and female koi fish that are more than 2 years old are kept in different ponds at a density of 1 fish/m3. The aim of separating the koi parents is to avoid natural spawning in the maintenance pond. Apart from broodstock whose gonads have matured, prospective broodstock are also kept in the broodstock pond. It is hoped that this mixing between the prospective parents and the koi parents will trigger the growth of the gonads of the prospective koi fish. Parent feed must be of high quality and meet the needs of parent koi fish for reproduction in accordance with SNI 7869:2013 for feed made by parent koi. Feeding koi parents is done in the morning and evening at satiation or as much as possible.

Koi Parent Selection

Parent selection is an important stage in koi fish hatchery. According to Sutisna and Sutarmanto (2012), the aim of parent selection is to obtain parents that have high productivity with desired morphological characteristics that can be inherited. Selection of koi fish aims to obtain new varieties with attractive colors and body shapes. The koi parents selected through the previous selection stage are parents who have mature gonads, both male and female parents. Koi fish parents who are ready to be spawned are usually at least 2 years old for female parents, while male parents are at least 1.5 years old. The characteristics of a male parent with mature gonads are that if he holds his body roughly, he can strip and release sperm which is milky white in color. Meanwhile, the characteristic of a female with mature gonads is that her stomach is large.

The criteria that must be considered in parent selection are that the parent has no defects, is in excellent physical condition, has agile movements, has complete body parts and has sharp colors and a clear color pattern. Putriana et al. (2015) stated that the criteria for selecting a good koi fish are an ideal body shape that is not wide, does not have a curved spine, bright and contrasting colors without any color gradations or shadows, the fish's movements are calm but agile and it is not isolated or sick.

Spawning

Koi fish spawning is carried out using natural spawning techniques with a ratio of female to male parents, namely 1: 3. The release of the parents is carried out in the afternoon starting with the release of the female parent and then the male. A good time to release the broodstock is in the morning and evening because at that time the water temperature tends to be low (Ismail and Khumaidi, 2016). Koi fish will spawn from dusk to dawn. The spawning behavior of koi fish is that the male parent will chase the female until the female parent ovulates and at the same time the male will release sperm. Fertilized koi fish eggs will stick to the substrate. During spawning, the parent koi fish will like to be under the natural substrate in the spawning pond which is used as a place to attach their eggs (Suseno, 2002). After the spawning process is complete, the mother koi fish are removed and moved to a quarantine area. This is done to prevent the eggs from being eaten by the parent after the spawning process is complete.

Egg drop

Fertilized koi fish eggs are clear, while unfertilized eggs are milky white. Efforts made to increase the hatching rate are by changing the water after spawning is complete. Water changes are carried out with the aim of removing remaining sperm and proteins in the water. This is done because if the remaining sperm and protein are not removed it can cause the eggs to be easily attacked by pathogens or fungi. So by changing the water by 50% you can get rid of the remaining sperm and protein in the water, and as a result the fertilized eggs can hatch. Koi fish eggs hatch 3 to 4 days after fertilization.

Larval rearing

Koi fish larvae hatch 3 to 4 days after fertilization. The egg yolk is used by the larvae as a food reserve/endogenous feeding for 1 to 2 days. The frequency of feeding twice a day, namely in the morning at 08.00 and 17.00, is given evenly. After the larvae are 7 days old, they are given silk worm food until the larvae are 14 days old ad libitum.

Larvae Harvesting

Larvae harvesting is carried out after a larval rearing period of 14 days. Larvae harvesting is done by reducing the water in the rearing pond, then the larvae are scooped out using a larva scoop and put into a tank where the larvae are ready to be stocked in the rearing pond.

Larvae Distribution

Before the larvae are spread in the rearing pond, the pond is prepared by drying, liming and applying fertilizer, then filling it with water. Filled ponds are left to sit for natural food to grow before larvae are stocked. Larvae distribution is carried out in the morning because the water temperature is still low. The larvae are transported using plastic bags, then the bags containing the larvae are floated in the pond for 5-10 minutes for temperature acclimatization. Then the pond water is added little by little to adapt to the new environment, after which the larvae will gradually emerge from the bag into the pond.

Feeding

Additional feed was given 2 days after the larvae were spread. The feed given is powdered pellet feed with a protein content of 35%. The frequency of feeding three times a day is given at satiation or as much as desired. When the larvae are 30 days old, the food given is larger in the form of floating pellets and still fits the larva's mouth opening with a protein content of 39%. Feed is given until the fry are 45 days old.

Seed Harvesting

Seed harvesting is done when the seeds are 45 days old or the seeds measure 3-5 cm. Seed harvesting is usually done in the morning because the temperature is still low. Harvesting is done by closing the inlet and opening the outlet pipe and replacing it with a pipe that has been cut into small holes so that the seeds do not come out of the pond when the water recedes. After the pool water recedes, the seeds are scooped up using a seed scoop and put in plastic to be transferred to the sorting tank.

Test Parameters

The test parameters observed in this research are as follows:

1. Fecundity

Fecundity is the number of mature eggs before they are laid in one spawning season. Fecundity measurements are carried out by weighing the weight of the parent fish before spawning and the weight of the parent fish after spawning. Fecundity is calculated based on Ishaqi and Sari (2019):

$$F = \frac{Wg}{Ws} \times 100\%$$

Information: F: Fecundity (items)
Wg: Total gonad weight (grams)
Ws: Gonad sample weight (grams)

2. Fertilization rate (FR)

The degree of egg fertilization or Fertilization Rate (FR) is the percentage of fertilized eggs from the number of eggs released during the spawning process (Larasati et al., 2017):

$$FR\ (\%) = \frac{\text{Number of fertilized eggs}}{\text{Number of total eggs}} \times 100\%$$

3. Hatching rate (HR)

The degree of hatching or Hatching rate (HR) is the number of eggs that hatch out of the total eggs that are successfully fertilized. Egg hatchability (HR) is calculated using the formula (Ishaqi and Sari, 2019):

$$HR\ (\%) = \frac{\text{Number of eggs hatched}}{\text{Number of fertilized eggs}} \times 100\%$$

4. Water Quality

Water temperature measurements are carried out every day in the morning and evening. Measurements of pH, DO, and ammonia are carried out once a week.

Data Analysis

Data analysis regarding koi fish hatchery techniques and parameters was carried out descriptively. The descriptive method is a method that aims to create a systematic, factual and accurate picture of the facts and characteristics as well as the relationships between the phenomena being studied (Nazir, 1988).

RESULT AND DISCUSSION

Fecundity

The results of calculating the fecundity of koi fish eggs are presented in Table 1 as follows.

Table 1. Koi fish egg fecundity data

Fertilized	Koi Fish Strain	Initial Weight of Parent (g)	Parent Final Weight (g)	Fecundity (grain)
1	Kohaku	900	860	30.000
2	Showa	950	890	35.000

The results of calculating the fecundity of koi fish eggs are in Table 1. It states that the spawning results of Kohaku broodstock produced a fecundity of 30,000 eggs and Showa broodstock of 35,000 eggs.

Fertilization rate (FR)

Based on calculations that have been carried out from egg fecundity data, the FR is 90.71%, resulting from the average of each egg sample calculation. Koi fish eggs are round, clear in color, 1.5-1.8 mm in diameter, and weigh 0.17-0.20 mg.

Table 2. Koi fish fertilization rate data

Fertilized	Koi Fish Strain	Total Number of Eggs (pieces)	Number of Fertilized Eggs (items)	Fertilization rate/FR (%)
1	Kohaku	30.000	27.000	90,00
2	Showa	35.000	32.000	91,43
Average				**90,71**

Hatching rate (HR)

The egg hatching process or hatching rate takes place after the parent has finished spawning. The eggs attached to the kakaban are left alone and will hatch after 2-3 days after spawning. The results of calculating the degree of hatching of koi fish eggs, namely 82.93%, were produced from the average of each egg sample count.

Table 3. Koi fish hatching rate data

Fertilized	Koi Fish Strain	Number of fertilized eggs (items)	Number of hatched eggs (items)	Hatching rate/HR (%)
1	Kohaku	27.000	22.000	81,48
2	Showa	32.000	27.000	84,38
Average				**82,93**

Life sustainability

Data on the survival rate (SR) of koi seeds aged 45 days can be seen in Table 4. Based on the SR calculation results, the average koi fish seed is 91.75%.

Table 4. SR data for 45 day old koi seeds

Fertilized	Stocking of larvae (tail)	Harvest seeds (tail)	SR (%)
1	22.000	20.000	90,91
2	27.000	25.000	92,59
Average			**91,75**

Seed selection

Selection of koi fish seeds, namely selection of size and color pattern. The first selection is carried out when the koi seeds measure 3-5 cm. The koi seeds that are taken and bred again are seeds that have a good color pattern. For seeds that are plain in color, they are not bred or sold. Data on the results of seed selection based on quality or grade can be seen in Table 5.

Table 5. Data on koi seed selection results based on quality

Fertilized	Number of seeds (tails)	High Quality (HQ) (ekor)	HQ (%)	Grade A (ekor)	Grade A (%)	Grade B (%)	Grade B (%)
1	20.000	100	0,5	400	2	500	2,5
2	25.000	200	0,8	500	2	400	1,6
Average	**22.500**	**150**	**0,65**	**450**	**2**	**450**	**2,05**

Water quality

Water temperature measurements are carried out every day in the morning and evening. Measurements of pH, DO, and ammonia are carried out once a week. The results of water quality measurements in larval rearing containers are presented in Table 6.

Table 6. Water quality measurement results

Parameter	Value	Quality standards
Temperature (^{0}C)	25-27	20-28
pH	7,9-8,5	6,5-8,0
DO (mg/L)	5,0-6,0	>5
Ammonia (mg/L)	0,01	<0,03

Factors that determine the level of fecundity are nutrition for gonad growth and a controlled environment. Kusrini et al. (2015) stated that fecundity is related to metabolism which reacts to changes in food supply and produces changes in egg growth, namely egg age, size and number of eggs, or the spawning cycle itself.

Egg size varies, depending on the age and size or weight of the parent. The embryo begins to grow inside the egg which is fertilized by spermatozoa. Fertilized eggs are characterized by a transparent yellow color, at the edges they look transparent and in the middle they are round brownish. Unfertilized eggs are pale and not transparent. Ramadhan and Sari (2018) stated that eggs that hatch will become larvae, while eggs that do not hatch are pale white, this indicates that the eggs have died. Factors that can influence the fertilization rate include egg quality, sperm quality, and water quality such as temperature and pH. The male parent used in spawning must be a quality parent because this will affect the sperm cells produced (Setyono 2009). Poor sperm cells can slow down the fertilization process and can result in the death of the egg. The condition of sperm that is still fresh is that the quality of sperm is still in good condition and its movement is active so that its ability to properly fertilize an egg is still possible (Kurniawan et al. 2013).

This result is an optimal result because the hatching degree is low if the percentage is not more than 45% (Satyani et al. 2010). The fertilization factor is largely determined by how many eggs can be fertilized by sperm, the more eggs fertilized by sperm, the higher the hatchability and vice versa. Hatching eggs are marked by a tail followed by eyespots. Factors that can influence egg hatching speed include water quality, namely water temperature (Saenal et al., 2020). The temperature during the fertilization process is 27°C and when the eggs hatch is 28°C (Safri et al. 2021). Temperature is an environmental factor that can influence average growth and determine hatching time and has a direct effect on the development process of embryos and larvae. Alim (2014) stated that different water temperatures at hatching fish eggs can provide different percentages of egg hatchability. The higher the water temperature in the egg hatching media, the faster the hatching time. The pH value of the water for egg hatching ranges from 7.2 - 8.0. According to Saleh et al. (2013) pH value 6.5 - 8.5 is the best for hatching koi fish eggs. Ramadhan and Sari (2018) state that the cause of egg death can be caused by several factors, including imperfect fertilization and the condition of the eggs sticking together or overlapping each other during distribution in the nest, so that oxygen circulation is disrupted and causes death.

Fish larvae are the most critical phase in fish cultivation because they have poor resistance and are vulnerable to changes in environmental conditions (Saputra, 2011). After the food reserves run out, additional food is given, namely egg yolks that have been boiled thoroughly and sieved using a sieve. According to Priyadi et al. (2010) requirements for suitable food for larvae are small size, and smaller than the larva's mouth opening. Water quality management is carried out with the aim of ensuring that water quality is always maintained and in accordance with water quality standards for

koi fish. Water quality is the most determining factor in the fish production process because water is the living medium for fish (Lastuti et al. 2000).

CONCLUSION

The fecundity of koi fish from the spawning of Kohaku and Showa parents is 30,000 eggs and 35,000 eggs respectively. The hatchery process includes pond preparation, parent selection, spawning, egg hatching, larval rearing, larval harvesting, larval stocking, feeding, seed feeding, water quality management, seed harvesting, and seed selection. The fertilization rate (FR) value obtained was 90.71% and the hatching rate (HR) was 82.93%. The average survival rate for koi seeds aged 45 days was 91.75% with an average of 150 high quality (HQ) grade seeds, 450 grade A seeds, and 450 grade B seeds. The temperature range in larval rearing ponds is 25-27 0C, water pH ranges from 7.9-8.5, DO ranges from 5.0-6.0, and ammonia is 0.01.

REFERNCES

Alim, M. (2014). Seminar Nasional Lahan Pegaruh Lanjut Suhu Pada Penetasan Telur dan Kelangsungan Hidup Benih Ikan Baung. Hemi Bagrus Memurus.

Augusta, T. S., Setyani, D., & Riyanti, F. (2020). Proses Pemijahan Semi Buatan dengan TeknikStripping (Pengurutan) pada Ikan Betok (*Anabas testudineus*). *Jurnal Ilmu Hewani Tropika*, 9(1), 29-34.

[DJPB] Direktorat Jendral Perikanan Budidadaya. (2019). Laporan Indikator Kinerja Triwulan I. Jakarta(ID): Direktorat Jendral Perikanan Budidaya.

Ismail & Khumaidi, A. (2016). Teknik Pembenihan Ikan Mas (*Cyprinus carpio*, L) di Balai Benih Ikan (BBI) Tenggarang Bondowoso. Samakia: *Jurnal Ilmu Perikanan*, 7(1), 27-37.

Ishaqi, A. M. A., & Sari, P. D. W. (2019). Pemijahan Ikan Koi (*Cyprinus Carpio*) dengan MetodeSemi Buatan: Pengamatan Nilai Fekunditas, Derajat Pembuahan Telur dan Daya TetasTelur. *Jurnal Perikanan dan Kelautan*, 9(2), 216–224.

Kifly, I., Halid, & Baso, H. S. (2020). Pengaruh Ketinggian Air Terhadap Konsumsi Oksigen Larva Ikan Mas Koi (*Cyprinus carpio*). *Fisheries of Wallacea Journal*, 1(2), 77-83.

Kusrini, E., S. Cindelaras, & Prasetio, A. B. (2015). Pengembangan Budidaya Ikan Hias Koi (*Cyprinus carpio*) Lokal di Balai Penelitian dan Pengembangan Budidaya Ikan Hias Depok. *Media Akuakultur*, 10(2), 71- 78.

Kurniawan, I. Y., Basuki, F., & Susilowati, T. (2013). Penambahan Air Kelapa Dan Gliserol Pada Penyimpanan Sperma Terhadap Motilitas Dan Fertilitas Spermatozoa Ikan Mas (*Cyprinus Carpio* L.). *Journal of Aquaculture Management dan Technology*, 2(1), 51-64.

Priyadi, A., Kusrini, E., & Megawati, T. (2010). Perlakuan Berbagai Jenis Pakan Alami untuk Pertumbuhan dan Sintasan Larva Ikan Upside Down Catfish (*Synodontis nigriventris*).

Putriana, N., Tjahjaningsih, W., & Alamsjah, M. A. (2015). Pengaruh Penambahan Perasan Paprika Merah (*Capsicum Annuum*) Dalam Pakan Terhadap Tingkat Kecerahan Warna Ikan Koi (*Cyprinus Carpio* L.). *Jurnal Ilmiah Perikanan dan Kelautan*, 7(2), 189-194.

Saputra, S. D. (2011). Aplikasi Sistem Resirkulasi Air Terkendali (SRAT) pada Budidaya Ikan Mas (*Cyprinus carpio*). Fakultas Teknologi Pertanian. Institut Pertanian Bogor. 5-27.

Suseno, D. (2002). *Pengolahan Usaha Pembenihan Ikan Mas*. Jakarta: Penebar Swadaya.

Ramadhan, R., & Sari, L. A. (2018). Teknik Pembenihan Ikan Mas (*Cyprinus carpio*) Secara Alami di Unit Pelaksana Teknis Pengembangan Budidaya Air Tawar (UPT PBAT) Umbulan, Pasuruan. *Journal of Aquaculture and Fish Health*, 7(3), 124-132.s

Saenal, S., Yanto, S., & Amirah, A. (2020). Perendaman Telur dalam Larutan Daun Ketapang (*Terminalia Cattapa* L) Terhadap Daya Tetas Telur Ikan Mas (*Cyprinus carpio* L). *Jurnal Pendidikan Teknologi Pertanian*, 6(1), 115-124.

Safri, S., Lahming, L., & Patang, P. (2021). Pengaruh Penggunaan Substrat Dengan Warna Yang Berbeda Pada Pemijahan Ikan Mas (*Cyprinus Carpio*). *Jurnal Pendidikan Teknologi Pertanian*, 6(2), 227-336.

Saleh, J. H., Zaidi, F. M. A., & Faiz, N. A. A. (2013). Effect of pH on hatching and survival of larvae of common carp *Cyprinus carpio* (Linnaeus, 1758). *Marsh Bulletin*, 8(1), 58–64.

Satyani, D., Meilisza, N. &, Solichah, L. (2010). Gambaran Pertumbuhan Panjang Benih Ikan Botia (*Chromobotia macracanthus*) Hasil Budidaya pada Pemeliharaan dalam SystemHapa dengan Padat Penebaran 5 Ekor per Liter. *Prosiding Forum Inovasi Teknologi Akuakultur*, 395-402.

Setyono, B. (2009). Pengaruh Perbedaan Konsentrasi Bahan Pada Pengencer Sperma Ikan "SkimKuning Telur" Terhadap Laju Fertilisasi, Laju Penetasan dan Sintasan Ikan Mas (*Cyprinus carpio L.*). *Jurnal GAMMA*, 5(1), 01-12.

Sutisna, D. H., & Sutarmanto, R. (1995). *Pembenihan Ikan Air Tawar*. Yogyakarta: Kanisius.