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Growth monitoring of koi fish (*Cyprinus carpio*) in natural hatchery techniques in Umbulan, Pasuruan, East Java

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Abstract. Koi fish (*Cyprinus carpio*) are one of the most popular ornamental fish commodities in the world. The purpose of this study was to analyze the growth and monitoring of koi fish on natural hatchery techniques. This research was conducted at the Technical Implementation Unit of Freshwater Aquaculture Development in Umbulan, Pasuruan, East Java Province between December 2017 and January 2018. The koi fish breeding technique in Umbulan is done naturally using two females with the same weight of 1.5 kg and three males with a weight of 1.8 kg, 1.5 kg and 1.5 kg respectively. The maintenance of the larvae included feeding, the monitoring of the larvae and the associated water quality measurements. The hatching rate of the koi fish eggs was 80%. The specific growth rate during maintenance was 0.164%, and the growth rate for every week was 1.822 x 10^{-3} g/day; 1.34 x 10^{-3} g /day; and 1.75 x 10^{-3}g /day. The feed conversion ratio was 1.38 and the survival rate was 73.8%. The average of the water quality values including temperature was 26.25° C. The pH was 7.53, the dissolved oxygen was 6.26 mg / L, NO_3 was 0.75 mg / L, NO_2 was 0.01 mg / L, Fe was 0.06 mg / L and PO_4 was 0.74 mg / L.

1. Introduction

Indonesia is one of the tropical countries that has a large potential for fish resources. One of them is ornamental fish, both fresh and marine. There are at least 240 types of marine ornamental fish and 226 types of freshwater ornamental fish. Freshwater ornamental fish are one of the items that are currently able to generate a lot of foreign exchange. The export value is very large and is increasing year to year. In 2011, the export of ornamental fish was 1,757 tons whereas in 2012, it increased by 7.88% to 1,896 tons [1]. The koi fish have great potential to advance the world of fisheries.

The great potential of the koi commodities in Indonesia is that it is progressing quite rapid lately, especially in areas such as Sukabumi, Cianjur, West Jakarta, Blitar, and Makassar. The magnitude of the transaction value and koi trade in Indonesia has made the government, through the Ministry of Maritime Affairs and Fisheries (KKP), interested in building several koi centers to become the largest koi producing area in the country through the concept of minapolitan. With this activity, KKP seeks to develop the potential of national ornamental fish, which is expected to improve the quality of local koi that can compete with imported koi, both in the domestic and international markets [2]. In addition, koi fish also have various types that are in great demand in the Indonesian market.

Koi, or nishikigoi, comes from "Nishiki", which means colorful. They are one of the most popular ornamental fish due to the beauty of its body shape and color. The following are types of koi fish according to the color patterns that have a fairly good and stable price on the world market: kohaku, taisho, koromo, hikari, showa, shiro, utsurimono, shusui, asagi, goromo, goshiki, bekko, tancho, kinginrin and kawarimono [3]. Koi subspecies are referred to as an important economic ornamental fish in China. The color combinations in koi fish have allowed them to grow into one of the most popular fish in the world [4]. The selling price of koi fish and goldfish has increased in line with the intensity of its skin color, which is an important quality criterion [5]. The existence of excess koi fish is an attempt to spawn koi fish.

Spawning is the process of releasing the egg cells by the female and sperm by the male, followed by the fertilization of the egg cell by the sperm (fertilization). In general, fish spawning can be done in two ways, namely natural and induction. Natural spawning is spawning that is carried out in the open in accordance with the nature of life without human treatment and assistance [6]. Natural spawning has excess and not too large costs [7]. The purpose of this study was to analyze the growth monitoring of koi fish in natural hatchery techniques.

2. Material and methods

2.1. Place and time

This research was conducted at the Technical Implementation Unit of Freshwater Aquaculture Development, Umbulan, Pasuruan, in the East Java Province, between December 2017 and January 2018.

2.2. Preparation of spawning pools

The preparation of the spawning ponds was done through drying, liming, fertilizing and filling the pond water. The construction resulted in the form of a concrete pond with a soil base of 5 x 20 x 0.8 m^3. Drying was done over 2 - 3 days under the sun. After the drying process, the bottom of the pond made of soil was calcified using calcium oxide (CaO) at a dose of 8 kg / 100m^2. The purpose of liming was to clean the pool of viruses and bacteria that are harmful to koi larvae, and lining also aims to raise the pH of the pond water into bases [8].

The next step after drying and lining was fertilization. The fertilization of the spawning pond was done with urea fertilizer (CH_4N_2O) at a dose of 10 g / m^2. Fertilization aims to support the availability of natural food for the koi fish larvae. The next step after fertilization was to install happa and to fill the spawning pond until the water was about 50 cm. The kakaban was then placed in the waring to lay eggs in the process of spawning the koi fish [8].

2.3. Parent selection

The parent selection in the Umbulan was carried out in the parent maintenance pond in two stages, namely gender and additionally based on the weight ratio of the parent fish. The first stage of the selection was based on sex, which was determined by pressing the belly of the fish. The koi fish that are male, when pressed on the abdomen, will release white liquid thick milk – this is sperm. The female fish seemed swollen in the abdominal area toward the urogenital region. When pressed, a clear yellow liquid emerged.

The second step was the selection based on the weight of the parent to be spawned. The total weight of the male parent must be greater than the female parent. This is so then the egg can be fertilized as a whole. If the number of sperm cells was less, then the result is that many of the eggs will not be fertilized, and therefore the eggs will die. The results of the selection of the koi parents in Umbulan determined 2 females at about 1.5 kg each, while the males weighed 1.8 kg, 1.5 kg and 1.5 kg. The koi broodstock in Umbulan have a varied pattern. An important element that determines the

value of a fish is the quality of the color. Brightness is determined by the number of chromophores on the skin and the tendency to collect pigments, generally during development, but also from the environment [9]. A good parent is one that has a pattern of bright, varied colors and a symmetrical body shape with a minimum weight of 1 kg. Male and female brooders that reached this size were immediately transferred to the feed pond for 24 hours [10].

2.4. Spawning

The koi broodstock, after the separation process, were then transferred to the spawning pond openly through a plastic bag plus water. The koi fish spawning technique in Umbulan was done naturally by using kakaban as the substrate where the fish eggs were attached (Figure 1). Spawning occurred around 10 pm to 12 am. The male parent will chase the female parent, and it will stick to the female parent. Furthermore, the female parent will then release her egg, attach it to the kakaban and waring and the male parent will secrete white sperm. After the observation the next morning, the koi egg was attached to both the waring and the kakaban.

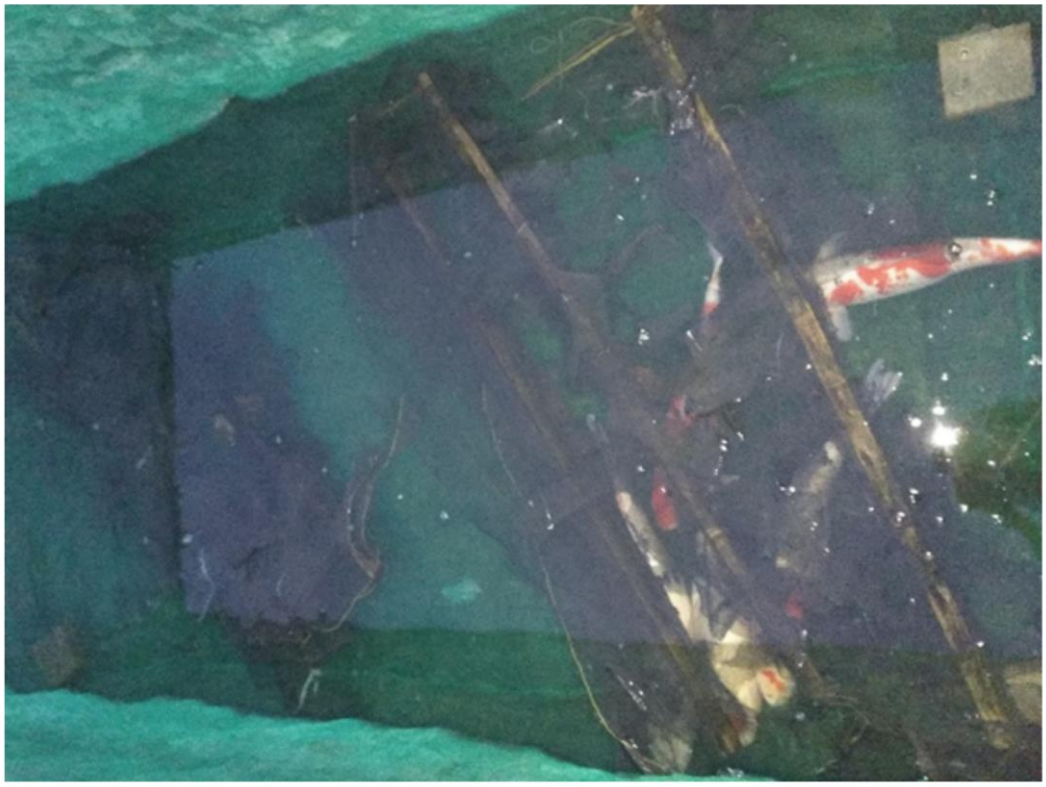


Figure 1. Spawning pool of the koi fish

2.5. Hatching eggs

After the spawning process, the koi fish eggs will hatch into larvae. Hatching eggs in Umbulan lasted for 2 days or 48 hours. The fertilized koi fish were marked with bright yellow. When the eggs hatched, the kakaban and waring were removed and cleaned from the eggs that did not hatch. The rest of the eggs that did not hatch were cleaned from the pond so as to not pollute the pool. After that, the koi parents were separated from the spawning pond so then the eggs and larvae were not fed on by the koi parents. Unfertilized koi fish eggs are milky white. The cause of the eggs experiencing death was due

to overlapping eggs clustering at the bottom of the pond, which meant that the oxygen circulation was disrupted and death occurred.

2.6. Feeding

After the egg yolk ran out in 3 days, the koi fish larvae were fed chicken egg yolks. The feeding was done by boiling the chicken eggs first, taking the yolk and then dissolving it into the pool water. Filtering was done using a filter and spreading it into the pool evenly in both the morning and evening. After 3 days, the koi larvae were fed pellets. The pellets were made into flour using the blind feeding method. Blind feeding is a guide to feeding that was developed by factories or individual farmers based on experiments [11].

Feeding was carried out twice a day in the morning and evening by distributing the feed evenly in the pond. The nutrient content of the koi fish pellets was 31 - 33% protein, 4 - 6% fat, 3 - 5% fiber and 9 - 10% moisture content. The koi fish feed was good because in order to get the optimum fish growth, it is necessary to add additional high-quality feed. This is the feed that met the nutritional needs of the fish. The nutritional value of the fish feed can be generally seen from the composition of the nutrients, such as the protein, fat, carbohydrates, vitamins, and minerals. In addition to the nutritional value of food, it is important to pay attention to the shape and size for it to compliment the fish that are being kept [12].

2.7. Water quality monitoring

The parameters measured for the water quality were pH, temperature (°C), DO (mg/l), salinity (ppt), NH_3, NO_3, NO_2, Fe and PO_4.

2.8. Data analysis

The parameters calculated include:

a. Hatching rate (HR); to determine HR, we used the following formula [13]:

$$HR\ (\%) = \frac{\text{The number of eggs hatched}}{\text{The number of sample eggs}} x\ 100\% \quad (1)$$

b. Survival Rate (SR); to determine Survival Rate (SR), we used the following formula [14]:

$$SR = \frac{NT}{NO} x\ 100\ \% \quad (2)$$

c. FCR (Feed Conversion Ratio); to determine the Feed Conversion Ratio, we used the following formula [15]:

$$FCR = \frac{F}{(Wt+D)-Wo} \quad (3)$$

d. Specific Growth Rate (SGR); to determine the Specific Growth Rate, we used the following formula [16]:

$$SGR = \frac{(Wt - Wo)}{t} x\ 100\% \quad (4)$$

e. Growth Rate (GR); to determine the Growth Rate, we used the following formula [17]:

$$GR = \frac{WT-WO}{t} \quad (5)$$

Where:

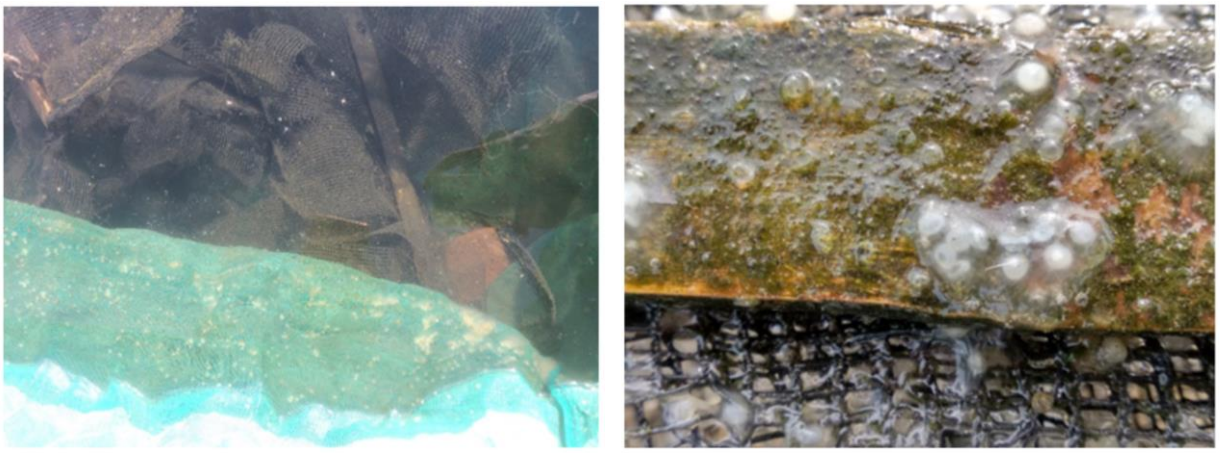
- Wt = Fish weight on the day (g)

- Wo = Fish weight at the beginning of the study (g)
- t = Maintenance Time (day)
- NT = The amount of fish harvested
- N0 = The number of fish stocked
- F = Amount of feed given (g)

3. Results and discussion

3.1. Hatching rate

The hatching rate (HR) of the koi fish was determined by the number of hatching eggs amounting to 88,000, with the number of eggs produced amounting to 110,000. The total HR from sampling five times was 80%. Generally the percentage of the hatching rate of fish normally ranges from 50 - 80%. This shows that the koi fish in Umbulan are still in a good range [18]. The data on the hatching and dead eggs has been shown in Figure 2.



a b

Figure 2. Hatching eggs (a) and dead eggs (b)

3.2. Larvae growth monitoring

The growth monitoring activities carried out at Umbulan aimed to determine the larval growth rate each week. The following are the charts for length growth and weight growth (Figure 3).

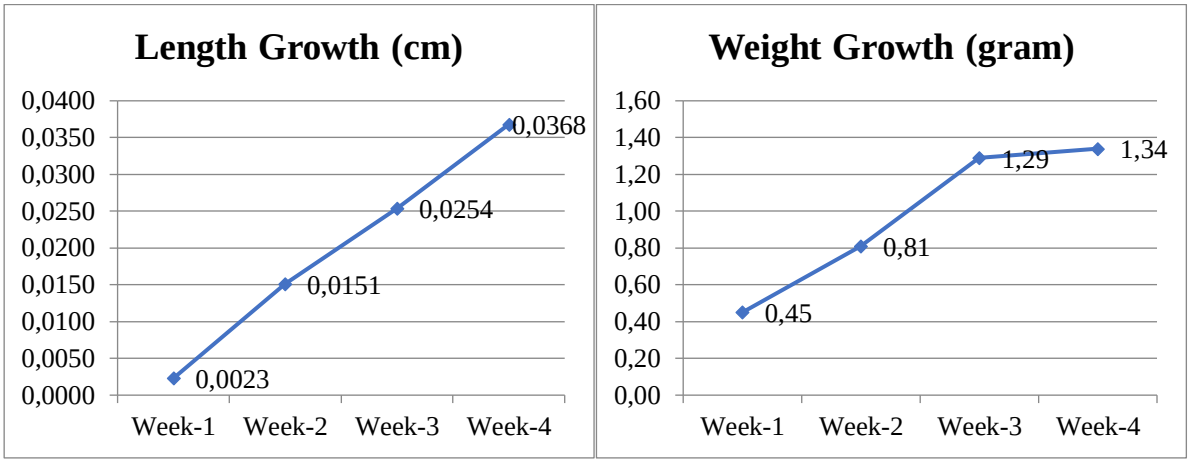


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Figure 3. Chart of length growth (a) and weight growth (b)

Larval growth depends on the factors of feed quality and water quality. Besides that, a stocking density that is too high in the context of the water is also not good for the growth of the koi fish larvae. The food factor is very important; it requires a good amount and quality of food to increase the weight and length of the fish. Additional food has a positive effect on the growth rate of the fish [19].

The calculation of the Specific Growth Rate (SGR) resulted in 0.164% and the Growth Rate (GR) for every week was 1.822 x 10^{-3} g / day; 1.34 x 10^{-3} gr / day; 1.75 x 10^{-3} g / day.

3.3. Water quality measurement

Water management aims to provide an optimal living environment for the survival of the fish, so then maximum growth can be obtained. Fish that live in an optimal environment can have a high appetite, which means that they grow and develop more quickly [20]. The monitoring of the water quality in Umbulan was carried out every day for temperature, pH, water brightness and DO in the morning and afternoon at 7:30 am and 2 pm respectively. In addition, there were measurements of NH_3, NO_3, NO_2, Fe and PO_4 taken every 2 weeks on the morning of 07:30.

Table 1. Measurement of the water quality

Parameter	Average Value	Standard Value
pH	7.53	6.5 – 8 [21]
Temperature (°C)	26.25	20-26 °C [21]
DO (mg/l)	6.26	>5 mg / L [21]
Salinity (ppt)	0	0 [21]
NH_3(mg / L)	0.15	≤ 1 mg / L [22]
NO_3(mg / L)	0.75	<50 mg / L [21]
NO_2 (mg / L)	0.01	0.2 mg / L [21]
Fe (mg / L)	0.06	1 mg / L [22]
PO_4(mg / L)	0.74	1 mg / L [22]

The measurement of the water quality in Umbulan was quite good because it complied with the standard water quality parameter for koi fish spawning. To prevent the increase of ammonia in the

pond water, this was done by limiting the amount of feed given or by controlling the pH in alkaline conditions. This is because ammonia easily evaporates under these conditions [23].

3.4. Survival rate

The calculation of the Survival Rate was done by harvesting and counting the total number of larvae. According to the calculation of the larval survival rates at the street vendor's location, the survival Rate during larval maintenance was 73.8%. This figure is relatively high, as the survival rate of larvae is usually 50 - 60% [24]. Good water quality in Umbulan can improve fish life. The quality of pond water is good, which means that the koi fish are healthy and grow beautifully. Conversely, if the quality of the pond water deteriorates, then the koi fish will be unhealthy and can even die suddenly [3].

3.5. Feed conversion ratio

The use of feed can be determined by calculating the feed conversion ratio, commonly known as FCR (feed conversion ratio). This was done by comparing the amount of feed given to the amount of fish weight gain [25]. The factors that influence the amount of consumption in fish are feeding habits, physiological status, fish weight, temperature, oxygen concentration, the composition of the feed, and their level of preference [26].

Based on the FCR calculation in the koi hatchery, the yield was 1.38. This result is good enough for fish farming because the resulting FCR was not too high. The quality of feed is influenced by the digestibility or absorption of the fish in relation to the food consumed. The smaller the feed conversion value, the better the quality of the feed. If the feed conversion value is high, then the fish feed is not good of a good quality [27].

3.6. Pest and disease control

Pests found in Umbulan include snails, frogs and snakes. These pests are detrimental to cultivation because snails often feed on koi fish. Frogs and snakes are detrimental to koi fish cultivation because they prey on smaller koi. The prevention method undertaken was to pull up the plants around the pond so they did not become a hiding place for frogs and snakes [3].

Diseases found in koi fish ponds include *Argulus* sp. *Argulus* sp attacks the koi fish in small amounts so as not to cause the death of the koi fish. *Argulus* sp, or fish lice, are common parasites of freshwater fish. This parasite has a direct life cycle and the adult female leaves the host and releases several hundred eggs in vegetation and various objects in the water. This causes pathological changes due to direct tissue damage and secondary infection [28]. *Argulus* has an oval shape like a disc with a diameter of 5 - 12 mm, a relatively flat surface, and four pairs of legs. The mouth and feet of Argulus sp damage the fin and body surface. *Argulus* sp. is a parasite that has a relatively large body size, so it is easy to find on the fish bodies [29]. How to deal with fish attacked by *Argulus* is by taking it off directly with tweezers.

4. Conclusion

During the observations, the koi length and weight growth continued to increase. The hatchery of the koi in the Technical Implementation Unit of Freshwater Aquaculture Development, Umbulan, Pasuruan, East Java was good enough. This can be seen from the high HR and SR values. One of the influencing factors is the good quality of the water.

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