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Survival Rate and Growth of Some Economical Freshwater Fish Species in Tailing Ponds of Bauxite Post-mining in Senggarang, Tanjungpinang City

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ABSTRACT

The tailing pond of bauxite post-mining in Senggarang, Tanjungpinang City, has the potential natural feed resource of phytoplankton and zooplankton. Moreover, the water quality of the tailing pond of bauxite post-mining has begun to support fish life. The objective of this study was to determine the survival rate and growth of some economical freshwater fish spescies in tailings ponds of bauxite post-mining in Senggarang, Tanjungpinang. The research was conducted by field experiment using a completely randomized design. There were different fish species as treatment: tilapia (*Oreochromis niloticus*), giant gourami (*Osphronemus goramy*), and tambaqui (*Colossoma macropomum*). Every treatment was carried out with five replications, with six fish in every cage replication. Monitoring the water quality and fish survival was conducted on the 0th, 10th, 20th and 30th days. The survival rate of from the highest to lowest were tambaqui (97±7%), tilapia (83±20%), and giant gourami (40±32%), respectively. The growth of fishes length from the highest to the lowest were gaint gourami (0.223±0.291cm), tambaqui (0.037±0.519cm), and tilapia (0.018±0.134cm). Meanwhile, all variety of fish tested had a decreased in weight: giant gourami -0.2310±1.3518 grams, tilapia -0.4281±1.1360 grams, and tambaqui -1.3498±1.4486 grams. The management of tailing ponds of bauxite post-mining in Senggarang for fisheries activities can be carried out by tambaqui (*C.macropomum*) culture cage with several conditions such as measurement of carrying capacity and capacity, management of water quality, feed, and technical aspects of culture.

Keywords: *bauxite, economical freshwater fish, growth, survival rate, tailing ponds*

ABSTRAK

Kolam *tailing* pasca tambang bauksit Senggarang, Kota Tanjungpinang, memiliki potensi sumber pakan alami berupa fitoplankton dan zooplankton. Selain itu, kualitas perairan kolam *tailing* pasca tambang bauksit sudah mulai mendukung untuk kehidupan ikan. Penelitian ini bertujuan untuk mengetahui tingkat kelangsungan hidup dan pertumbuhan beberapa spesies ikan ekonomis air tawar pada kolam *tailing* pasca tambang bauksit di Senggarang, Tanjungpinang. Penelitian dilaksanakan melalui eksperimen di lapangan menggunakan rancangan acak lengkap (RAL). Perbedaan jenis ikan sebagai perlakuan: nila (*Oreochromis niloticus*), gurami (*Osphronemus goramy*), dan ikan bawal air tawar (*Colossoma macropomum*). Setiap perlakuan dilakukan 5 ulangan, dengan jumlah ikan sebanyak 6 ekor di setiap ulangan keramba. Monitoring kualitas perairan dan kelangsungan hidup ikan dilakukan pada hari ke-0, ke-10, ke-20, dan ke-30. Kelangsungan hidup dari yang tertinggi sampai terendah secara berturut-turut adalah ikan bawal air tawar (97±7%), ikan nila (83±20%), dan ikan gurami (40±32%). Pertumbuhan panjang ikan dari yang tertinggi sampai yang terendah yaitu ikan gurami (0,223±0,291cm), ikan bawal air tawar (0,037±0,519cm), dan ikan nila (0,018±0,134cm). Sementara itu, semua jenis ikan yang diuji mengalami penurunan bobot: ikan gurami 0,2310±1,3518 gram, ikan nila -0,4281±1,1360 gram, dan ikan bawal air tawar -1,3498±1,4486 gram. Pengelolaan kolam tailing pasca tambang bauksit di Senggarang untuk kegiatan perikanan dapat dilakukan melalui

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kegiatan budidaya ikan bawal (*Colossoma macropomum*) dengan beberapa syarat seperti pengukuran daya dukung dan daya tampung, manajemen kualitas air, pakan, serta aspek teknis budidaya.

Kata Kunci: *bauksit, ikan ekonomis air tawar, pertumbuhan, kelangsungan hidup, kolam tailing*

1. Introduction

Bintan Island is one of the bauxite producers in Indonesia. According to Rohmana et al. (2007), bauxite mining in Bintan Island started in 1935, and was closed in 2009 (Ministry of ESDM, 2012). One of the bauxite mining activities in Bintan Island has stopped, located at Senggarang Village, Tanjungpinang City. The bauxite mining activity that has stopped would leave the abandoned bauxite mining pits. The remaining washing of bauxite and overflow of rainwater could became a new aquatic ecosystem, called tailing pond. According to Puspita et al. (2005), the water of post-mining ponds can not be used directly, because it was contained high pollutants. The water of post-mining ponds will be the natural ecosystem likely, depends on the age of the ponds (innudated time). Pond mining could beused for various activities, such as fisheries activities.

One of pioneer organism that lived in an aquatic ecosystem is plankton. Plankton is one of the natural foods for fish, especially plankton feeders fishes. The tailing ponds of bauxite post-mining in Senggarang found various types of phytoplankton with total abundance of 1,692-2,525 cells.L^{-1} (Apriadi and Ashari, 2018) and also zooplankton, especially *Brachionus* with abundance of 60-216 ind.L^{-1}. *Brachionus* sp. is one type of zooplankton derived from phylum Rotifera, Eurotatoria class, and order Brachionidae. Rotifer was known as natural food for fish, especially for fish larvae.

Based on observations, certain types of fish were also found in tailing ponds of bauxite post-mining in Senggarang. It was indicated that there could be inhabited by a high level organisms, such as fish. Based on the research of Apriadi et al. (2018), several species of fish were found in the bauxite post-mining ponds in Bintan islands. Although it has a low diversity value compared to natural wetlands, it is not significantly different. The presence of fish could be indicated that tailing ponds tend to be stable ecosystem. After innudation time, several organisme would be able to live in post-mining pond, but the number and type are still limited (Puspita et al., 2005).

The tailing ponds of bauxite post-mining in Senggarang, Tanjungpinang City had have natural feed for fishes to support fish life. The fish survival rate need to be known for management of bauxite post-mining pond through the fisheries sectors, especially for aquaculture. So, this study need to be conducted to determine the survival rate of some freshwater economical fishes. The objective of this study was to determine the survival rate and growth of some economical freshwater fish species in tailing ponds of bauxite post-mining in Senggarang, Tanjungpinang City.

2. Materials and Methods

2.1. Time and area of study

This study was conducted on June-July 2018. Survival rate and growth observation were carried out in tailing ponds of bauxite post-mining in Senggarang Besar, Senggarang Village, Tanjungpinang Kota District, Tanjungpinang City, Riau Islands Province (Figure 1). Analysis of plankton and water quality parameters were carried out at the Laboratory of Faculty of Marine Sciences and Fisheries, Raja Ali Haji Maritime University, Senggarang, Tanjungpinang City and Center for Environmental Health Techniques and Disease Control, Batam.

2.2. Tools and Material

The tools and materials in this study were floating net cages, fish seeds (tilapia, giant gourami, and tambaqui), instruments for measuring water quality such as multitesters, plankton nets, sample bottles, lugol 10%, and instrument for counting and identified phytoplankton in laboratory such as microscope and Sedgewick rafter counting chamber cell (SRC).

2.3. Methods

The research was conducted by field experimental, used a completely randomized design. There were different fish species as treatment: tilapia, giant gourami, and tambaqui. These species were chosen because they have economic value. In addition, these fishes were classified as economical fish species that are sensitive to changes in water conditions. so the survival rate of these fishes can describe the water quality of the tailings pond. The size of the fish used were juvenile ranged from 5-6 cm. Every treatment was carried out with five replications, with six fish/floating cage. The cage used 1 x 1 m with a depth of 1 m. The fish juvenile were acclimatized to the tailing ponds of bauxite post-mining. During 30 days of experiment, fishes were cultivated without artificial feed. It is done so that fish eat natural feed from the tailings pond. So that, the fishes survival rate can describe the real condition of bauxite tailings ponds. Data on fish survival and water quality measurements (temperature, turbidity, pH, dissolved oxygen (DO), and plankton abundance) were observed at 0, 10, 20, and 30-day. Ammonia, iron (Fe), and cadmium (cd) were measured at the beginning and the end of this study. Water quality measurements was conducted based on APHA (2012).

Fish survival was calculated using the formula of Nirmala and Rasmawan (2010).

$$\mathrm{SR} = \frac{\mathrm{Nt}}{\mathrm{N0}} \times 100\%$$

Description:

SR : Survival rates (%)
Nt : total live fish at the end of the study. (individual)
N0 : total fish at the beginning of the study (individual)

Fish growth was measeured by weight and length of fishes. There is the growth formula of fish weigth (Effendie, 1997):

$$W = Wt – W0$$

Description:

W : Growth of fish weight (grams)
Wt : fish weigth at the end of the study. (grams)
N0 : fish weight at the beginning of the study (grams)

Growth of fish length was calculated using the formula of Nirmala and Rasmawan (2010).

$$Pm = Lt – L0$$

Description:

Pm : Growth of fish Length (cm)
Lt : fish length at the end of the study (cm)
L0 : fish length at the beginning of the study (cm)

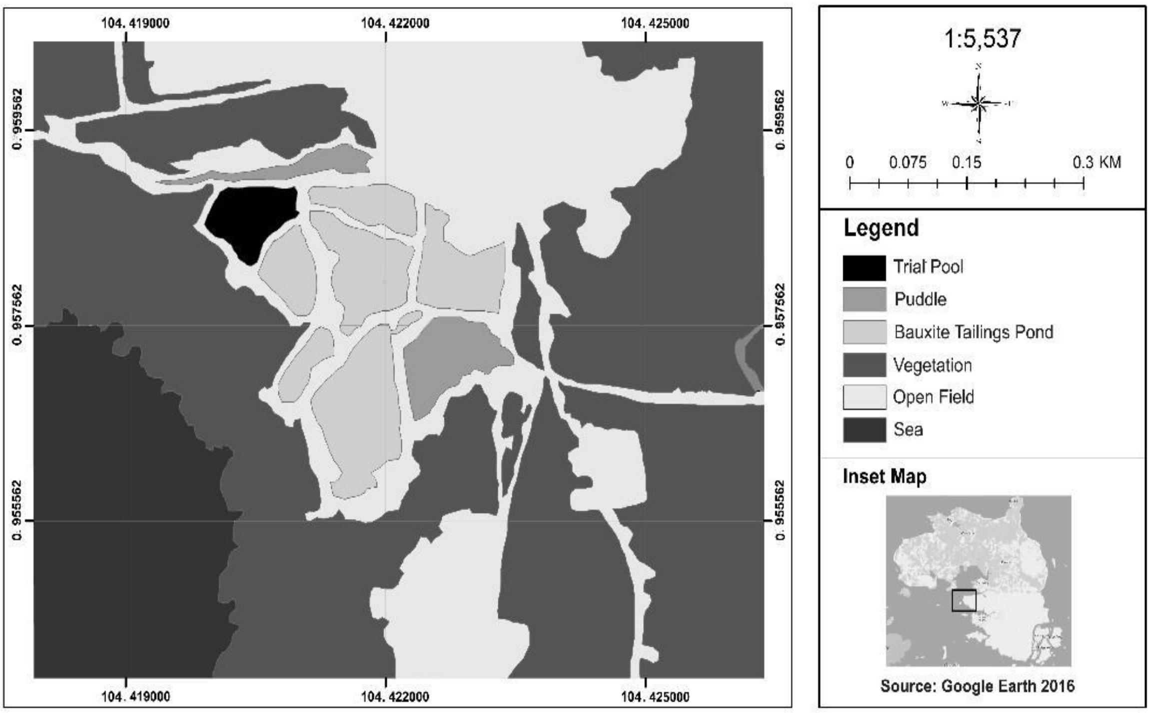

Figure 1. Map of research location

2.4. Data analysis

The data obtained will be processed using ms.excel and displayed in the form of tables, bar charts, pie charts, and graphs. In addition, one way ANOVA analysis was also conducted to see the effect of different types of fish on the survival rate of fish species in tailing ponds of bauxite post-mining in Senggarang, Tanjungpinang City.

3. Results and Discussion

3.1. Level of Fish Survival

The results of one way ANOVA analysis obtained the results of F count> F table. This mean that there is a significant effect on differences of fish species to fish survival rates in tailing ponds of bauxite post-mining. The test results of least significance different (LSD), showed that tilapia and tambaqui were not significantly different. Meanwhile, giant gourami was significantly different from tilapia and tambaqui. Giant gourami has very low survival compared to tilapia and tambaqui (Figure 2).

Based on Figure 2, tilapia and tambaqui do not have significant survival differences (marked with the letter b). That is because the survival rate of the two fish species is not much different (97 ± 7% for tambaqui and 83 ± 20% for tilapia). Tambaqui has the highest survival rate (97±7%). This indicated that the tailing ponds of bauxite post-mining in Senggarang village was suitable for the life of tambaqui. Tambaqui has a high survival rate because of its high adaptability to the environment and feed. According to Kordi (2010), tambaqui has several advantage: omnivorous and can grow with foods that content lower protein than other fish, and can survive in waters with low oxygen content. The abandoned bauxite mining pits in Senggarang were was low primary productivity and oligotrophic waters (Apriadi et al., 2019).

Giant gourami has the lowest survival rate of the two other types of fish tested (40±32%). Giant gourami was not suitable for cultured in tailing ponds of bauxite post-mining in Senggarang village, especially by using a floating net cage system.

Giant gourami has low survival because the amount of food was not supported in tailing ponds of bauxite post-mining. Small size of giant gourami (total body length of 3.5-5.5 cm) tend to be carnivorous with the main food in the form of insects (Affandi 1993). The abundance of plankton in the tailing ponds of bauxite post-mining, only eight types of zooplankton were found with a total abundance ranging from 19-57 ind.L^{-1}. According to Lucas et al. (2015), nutrients in foods such as protein, fat, carbohydrates, vitamins, and minerals determine the success of fish survival.

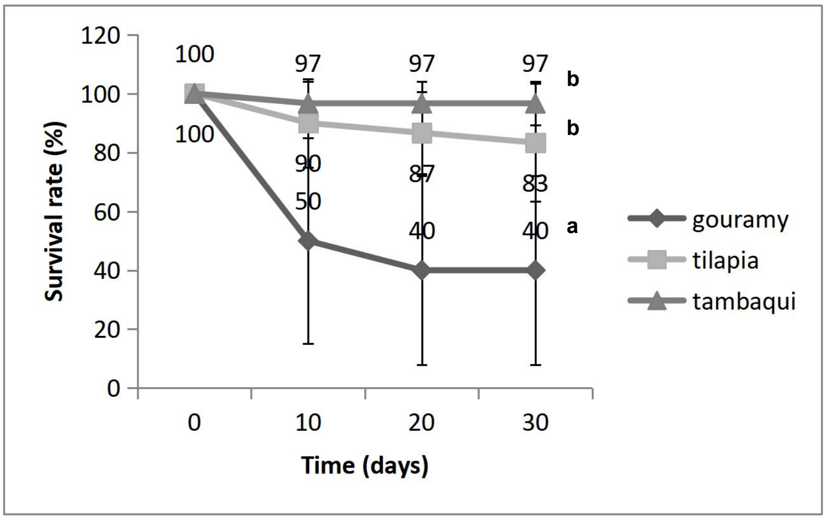

Figure 2. Fish survival rates in tailing ponds of bauxite post-mining (note: Different letters at the end of the graph show differences between treatments)

Based on observations, most of the fish survival has decreased in early 10 days. Giant gourami had the higest mortality in the early 10 days, which was 50±35%. Besides from the availability of feed, the mortality of giant gourami was due to changes in environmental conditions. Some environmental parameters changes that occurred in early 10 days were decreasing water temperature, increasing water pH conditions, and drastically increasing plankton abundance (Table 2). Most aquatic biota are sensitive to pH changes (Apriadi et al, 2018). Although having low pH, some of fishes tested in this study were still able to live well. Decreasing water temperature can affect the physiological activity of giant gourami. The water temperature measured on day 0 and day 10 was 29.4±1.1 ^oC and 27.2±0.1^oC, respectively. Following to Syamdidi et. al. (2006), decrease in temperature from 29.2-26.1^oC resulted in giant gourami starting to lose balance, the response of stimuli starting to decrease, and the fins and operculum movement starting to be weak.

3.2. Fish Growth

The fish length has increased at the end of study. Giant gourami has the highest length gain, with growth of 0.223±0.291 cm within 30 days. Tilapia has the lowest length gain. The average tilapia length gain was 0.018±0.519 cm (Table 1). Giant gourami has the longest long-term growth due to the absence of food competition. Giant gourami has the highest mortality (Figure 2), so food competition was low and effect in increased opportunities to get food for growth. The difference in stocking density will affect fish growth. Meanwhile, low stocking density will produce a higher growth rate than higher stocking density (Islami et al., 2013). Low fish density will provide optimal growth compared to high density. In the other hand, high density will slow fish growth due to food competition.

Tabel 1. Fish growth in tailing ponds of bauxite post-mining

Type	Growth	
	Average of Weight Gain (gram)	**Average of Length Gain (cm)**
Tilapia	-0.4281±1.1360	0.018±0.519
Giant Gourami	-0.2310±1.3518	0.223±0.291
Tambaqui	-1.3498±1.4486	0.037±0.134

In addition, fish growth was also influenced by the quality of fish food, especially the protein content. Based on the study of Nofyan (2005), the growth of fish fed animal feed has a higher growth than fish fed plant-based feed. That is because animal feed has a higher protein content than plant-based feed. Based on the results of the analysis of fish food types, only in the gut of giant gourami were found pieces of Crustacean body. This indicated that giant gourami in tailings ponds of bauxite post-mining tend to like foods that contain high protein.

Tilapia has the lowest length gain thought to be influenced by the protein content in feed. The protein content in the feed needed for tilapia is greater than that of giant gourami and tambaqui. Tilapia needs feed with a protein content ranging from 25-35%, giant gourami 24-32%, and tambaqui only 25-27% (Kordi, 2010).

However, all types of fish tested had decreased body weight. That is because during the testing period, fish only survive using available natural feed in this pond. In addition, the decrease in fish weight was thought influenced by low water pH conditions. This caused the metabolic process of fish to increase due to fish adaptation, so that a lot of energy was needed for the metabolic process. Acidic or basic water conditions will cause metabolic and respiratory disorders (Mainassy, 2017). The highest reduction in fish weight was tambaqui and the lowest weight reduction was giant gourami. Tambaqui experienced the highest reduction in weight allegedly due to several things, such as lack of nutrients contained in the feed, as well the activity of these fish. Tambaqui is an active fish. This will increase the metabolic process, so that energy obtained from nutrients is used for metabolic activities rather than for growth. According to Santoso and Agusmansyah (2011), amino acids obtained from protein will be used for metabolic activities, cell maintenance, and body tissues, and the remainder is used for growth.

3.3 Water Quality

The tailings pond waters of bauxite post-mining do not yet have a specific designation, so used the water quality standard according to the Indonesian Government Regulation No. 82 year 2001 2nd Class (PP No. 82 of 2001 class II) which one of its allotments for fisheries. Based on the water quality standard of PP No. 82 of 2001 class II, the parameters of pH, ammonia, iron (Fe) and cadmium at the beginning did not meet the quality standards. While other water quality parameters have met the quality standards (Table 2). According to Kelabora and Sabariah (2010), fish can live well and grow quickly in water that has good quality.

The average water pH measured ranged from 3.37 to 4.16 and was classified as low (acid). The lowest average pH was found in the 0 day observation. The highest average pH was found in the 10th day of observation. Based on PP No. 82 of 2001, the pH of the tailings pond waters of bauxite post-mining did not meet class II quality standards. A good pH value to which ranged from 6.8 to 8.5 (Tatangindatu et al., 2013). According to Apriadi and Ashari (2018), the low pH of bauxite tailings pond waters was thought to be affected by the rainy season, dissolved ions in the waters, and low sediment pH. The measured average pH tends to fluctuated on each measurement. It is thought to be influenced by stirring pH on sediments due to the flow of rainwater.\Based on PP No. 82 of 2001, the concentration of ammonia in bauxite tailings pond waters did not meet the quality standards at the beginning and end of the activity. The concentration of ammonia (NH_3) at the beginning and end of activities were closely related to pH conditions and dissolved oxygen (DO) content of waters. Low pH and low DO will prevent ammonia from being converted to nitrate. Low pH conditions will inhibit the nitrification process (Apriadi and Ashari, 2018). In addition, according to Krismono (1998) to convert ammonia (NH_3) to nitrate (NO_3) required the aerobic bacteria (with sufficient oxygen). This has been supported by the relatively low pH measurement and increased DO at the end of the study. The presence of ammonia in the waters could be damage to the function and organ structure of aquatic biota (Sutomo, 1989).

The content of heavy metals in waters will be dangerous for biotas that live in these waters. Some types of metals in small concentrations are also needed by living things, but will be toxic if in large numbers. The presence of heavy metals in water depends on the minerals in the region. In addition, the content of heavy metals is very dependent on the pH of the water. The pH of acidic water can increase heavy metal content in the waters. According to Prasetiyono (2015), waters that have a low water pH will dissolve metals in the sediment or under the area.

Although some water quality parameters do not meet the quality standards for fish culture, two types of fishes (tambaqui and tilapia) were able to live. It was proved that these species were able to tolerate and adapt to water with a low pH (3.37 to 4.16), as well as ammonia, iron and cadmium are high. This is certainly a golden opportunity to improve the welfare and economy of the local community through freshwater fish culture activities by utilizing tailings pond of bauxite post-mining. In addition, tambaqui and tilapia are the economical species of fish that are consumed by many people.

Table 2. The water quality in tailing ponds of bauxite post-mining

	Parameters	Time (Day)				Quality standards*
		0	10	20	30	
	Physical					
1.	Temperature (°C)	29.4±1.1	27.2±0.1	30.5±0.3	31.8±0.5	Deviation 3
2.	Turbidity (NTU)	1.55±1.02	0.99±0.41	0.50±0.61	0.66±0.56	
	Chemical					
1.	DO (mg/L)	7.6±0.2	7.6±0.1	6.6±0.2	6.7±0.3	4
2.	pH	3.37±0.08	4.16±0.04	3.93±0.04	4.04±0.02	6-9
3.	Ammonia (mg/L)	0.05±0.03	na	na	0.05±0.02	≤0.02
4.	Iron (mg/L)	0.113±0.005	na	na	0.027±0.006	-
5.	Cadmium (mg/L)	0.053±0.001	na	na	0±0	0.01
	Biology					
1.	Plankton (ind/L)	2,318	11,198	7,458	2,897	

*Water quality standard according to the Indonesian Government Regulation No. 82 year 2001 Class 2nd

na: not analyzed

4. Conclusion

Different fish species will affect the survival rate of fish in tailing ponds of bauxite post-mining. The survival of economical fish in tailing ponds of bauxite post-mining from the highest to lowest tambaqui (*C. macropomum*) by 97±7%, tilapia (*O.niloticus*) by 83±20%, and giant gourami (*O. goramy*) of 40±32%, respectively. The growth of fishes length from the highest to the lowest were gaint gourami (0.223±0.291cm), tambaqui (0.037±0.519cm), and tilapia (0.018±0.134cm). Meanwhile, all variety of fish tested had a decreased in weight: giant gourami -0.2310±1.3518 grams, tilapia -0.4281±1.1360 grams, and tambaqui -1.3498±1.4486 grams. The management of tailing ponds of bauxite post-mining in Senggarang for aquaculture can be carried out by tambaqui (*C.macropomum*) culture cage.

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