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Research Article

Growth performance of Tilapia (*Oreochromis niloticus*) cultivated in water from ex-sand pit lakes by phytoremediation treatments

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Abstract

Utilization of ex-sand pit lakes for aquaculture is difficult due to low water quality and high concentrations of iron (Fe). Phytoremediation using aquatic plants has been proven to be effective in reducing Fe in waters. This study aims to determine the growth, feed conversion efficiency and survival rate of tilapia (*Oreochromis niloticus*) cultured with ex-sand mining water media with phytoremediation treatment. Phytoremediation treatment was carried out by *Eichhornnia crassipes, Azolla pinnata,* and *Salvinia molesta*. Fish culture experiments were carried out in plastic tarpaulin tanks for 40 days, with ad satiation feeding, three times a day using the commercial feed. The results showed that phytoremediation with aquatic plants had succeeded in reducing Fe to a level suitable for fish culture. Fish culture experiments showed an absolute length growth rate of 0.09-0.18 cm/day and an absolute weight growth rate of 0.11-0.16 g/day. The feed conversion ratio was 1.18-1.40, and the survival rate was 98.04-99.08%. The survival rate of tilapia is high, the feed conversion ratio is medium, and growth is low. The high environmental temperature and the decrease in water quality due to the absence of water changes and aeration are suspected of causing the low growth of fish. Therefore, further research with water change and aeration experiments and the use of other species of fish is needed to follow up the results of this study.

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Introduction

Mining activities always have two opposing sides, as a source of prosperity (Widiati, 2007) and a potential cause of environmental damage (Dong-sheng et al., 2009; Setiawati, 2012). Indonesia was ranked 2nd in the world's coal exporter in 2015, 2nd in tin producer, 3rd in copper producer, 4th in nickel producer, and 8th in gold producer (Gautama, 2007). Currently, the production of sand mining in Indonesia has not been widely published. The total amount of sand mining production is estimated to be much larger than other mining materials types. One area that has enormous sand mining potential is East Lampung Regency (Supardan et al., 2006). Very intensive sand mining activities in Pasir Sakti Sub-district have formed vast ex-sand pit lakes (Firdaus, 2012; Malik, 2017), which are estimated at 1,200 ha (Hasani et al., 2021a). The condition of the former sand mining lakes in Pasir Sakti Sub-district is currently not being utilized, both for agricultural and aquaculture purposes. According to Firdaus (2012), water quality in ex-sand pit lakes in Pasir Sakti Sub-district is acidic (pH 4.5-6) with high concentrations of Fe and Si. This condition is commonly found in sand mining pit lakes (Darmayanti et al., 2000). The ex-mining area containing metals and acids phenomenon is known as the acid mine drainage (AMD) (Commonwealth of Australia, 2016; Ambiado et al., 2017; Runtti et al., 2018).

According to the Fisheries and Marine Affairs Service of Lampung Province (2017), the concentration of Fe in the waters of the ex-sand pit lakes in Pasir Sakti Sub-District, East Lampung reached 0.22-1.54 mg/L, while according to Hasani et al. (2021a), it reached 0.15-5.89 mg/L. The results of the analysis of the suitability of the water quality of ex-sand pit lakes for the tilapia (*O. niloticus*) culture conducted by Hasani *et al.* (2021a) showed that the level of waters suitability was 64-68%, which was considered as marginally suitable. The low value of land suitability is mainly influenced by physical and chemical parameters, namely brightness, dissolved oxygen, temperature, pH, ammonia, phosphate, and Fe concentration. Therefore, severe treatment is needed to improve water quality to make it suitable for fish culture. One of the efforts that can be made to improve water quality is phytoremediation using aquatic plants (Singh et al., 2012; Ajibade et al., 2013; Shafi et al., 2015; Noorjahan and Jamuna, 2015; Yunus and Prihatini, 2018). Furthermore, Hasani et al. (2021b) and Hasani et al. (2021c) had succeeded in reducing Fe in water from ex-sand pit lakes in Pasir Sakti Sub-District by using aquatic plants *E. crassipes* and *A. pinnata* to achieve water quality suitable for tilapia (*O. niloticus*) culture. This study aimed to test the cultivation of tilapia (*O. niloticus*) using water from ex-sand pit lakes with phytoremediation treatment of several species of aquatic plants.

Materials and Methods

Water quality remediation experiment design

This research was conducted in an open space using tarpaulin tanks measuring 1.5 x 1.5 x 1 m^3. The tarpaulin tanks were cleaned first by washing with clean water and then drying. Experimental tanks were filled with water from ex-sand pit lakes with a height of 50 cm. The phytoremediation experiment used a completely randomized design with four treatments and three replications. The treatments tested were FK (water from ex-sand pit lakes as control), F1 (*E. crassipes*), F2 (*A. pinnata*), and F3 (*S. molesta*). The use of aquatic plants referred to Hasani et al. (2021b) and Hasani et al. (2021c), who have succeeded in reducing the concentration of Fe in water from ex-sand pit lakes so that the Fe concentration becomes suitable for fish culture, which is less than 0.03 mg/L (referring to Krismono et al., 1998), for 21 days of treatment. The combination of factors and treatments of phytoremediation were as follows:

A	FK	:	water from ex-sand pit lakes (as control)
B	F1	:	water from ex-sand pit lakes with *E. crassipes* treatment
C	F2	:	water from ex-sand pit lakes with *A. pinnata* treatment
D	F3	:	water from ex-sand pit lakes with *S. molesta* treatment

The treatment tanks were placed randomly in each block/factor by drawing lots so that the data analysis was valid and all samples received the same treatment. The best water quality from the results of each treatment was used for the cultivation of tilapia (*O. niloticus*).

Tilapia culture experiment

Tilapia culture experiments were carried out using tarpaulin tanks (semi-laboratory). The experimental design used was a completely randomized design (CRD) with four treatments and three replications. The main factor was water from ex-sand pit lakes resulting from phytoremediation treatments. Water with the best quality was selected from each treatment. Furthermore, each of these treatments was used as a culture medium for tilapia. The treatments built were water with the best quality in FK as control (treatment A), water with the best quality on F1 (B), water with the best quality on F2 (C), and water with the best quality at F3 (D). At the same time, the experimental fish was Tilapia (*O. niloticus*). The replication tanks were placed randomly. The combination of factors and treatments in this experiment were as follows:

A	FK	:	water from ex-sand lakes + tilapia (as control)
B	F1P1	:	best quality water from the results of F1 remediation experiments + tilapia
C	F2P1	:	best quality water from the results of F2 remediation experiments + tilapia
D	F3P1	:	best quality water from the results of F3 remediation experiments + tilapia

Fish preparation and culture

The fish used were red tilapia seeds measuring 2-3 cm with a density of 150 fish in each experimental tank. The fish used were healthy, active, swimming against the water flow, uniform in size, and not deformed. Acclimatization of the fish was carried out before placing the fish into experimental tanks. Fish stocked in experimental tanks were cultured for 40 days. Feed was given ad satiation three times a day at 07:00, 13:00 and 17:00. The feed given was commercial feed in the form of pellets of PF 1000 with a size of 1.3-1.7 mm. The feed contained 39-41% of protein, 5% of fat, 6% of fibre, 18% of ash, and 10% of water. There was no water replacement during the experiment, except for the addition of water from the reservoir to replace water lost due to evaporation.

Measurement of water quality and fish growth

Water quality measurements, including temperature, pH, dissolved oxygen, ammonia and Fe concentration, were carried out regularly once a week (7 days). Along with measuring water quality, the absolute weight growth and absolute length growth of fish were also measured (Huwoyono and Kusmini, 2010). Thirty percent of the fish population were randomly selected to estimate the average length and weight. The amount of feed, survival rate (SR) (Zonneveld et al., 1991; Effendi et al., 2017)), and feed conversion rate (FCR) were also measured. The weight of the test fish was calculated following Effendi (2006) as follows:

W = wt-wo

where :

W	:	absolute weight growth (g)
Wo	:	average weight of fish at the beginning of culture (g)
Wt	:	average weight of fish at the end of culture (g)

Fish length is the difference between the length of the fish from the tip of the head to the tip of the tail of the body at the end of the study and the beginning of the study (Effendi et al., 2017). The absolute length gain was calculated using the formula of Effendie (2006) as follows:

Lm = lt - lo

where :

Lm	:	absolute length growth (cm)
lo	:	average length of fish at the beginning of culture (cm)
lt	:	average length of fish at the end of culture (cm)

The survival rate (SR) was calculated by the formulation of Zonneveld et al. (1991); Effendi et al. (2017) as follows:

$$SR = \frac{Nt}{No} x100\%$$

where :

SR	:	Survival rate (%)
Nt	:	Number of live fish at the end of culture
No	:	Number of live fish at the beginning of culture

Furthermore, the Feed Conversion Ratio (FCR) was also calculated, which is the ratio between the amount of feed given to the growth of the fish. FCR was following Effendi (2006) and USAID (2011) as follows:

$$FCR = \frac{\text{Total weight of dry feed given (g)}}{\text{Total wet weight gain (g)}}$$

Data analysis

The data obtained were subjected to the analysis of variance (ANOVA) at a 95% confidence level followed by the Duncan Multiple Range Test (DMRT).

Results and Discussion

Water quality

The results of observations of water quality are presented in Table 1. Water temperatures were relatively uniform in all treatments, ranging from 28-33 °C. The temperature tended to be high because the research location is lowland and close to the coast. According to Djarijah (1995), the appropriate temperature range for tilapia culture is 25-30 °C, while the research of Makori et al. (2017) showed a temperature range of 27-30 °C.

The pH value showed a fluctuating range from 4.2 to 8.9. The range of pH fluctuations was relatively wide; this caused disruption of fish growth, although not to the point of causing death. According to Djarijah (1995), a good pH for tilapia culture ranges from 6.5 to 8.5. According to Boyd (1990), a good pH value for fish culture is 6.5-9.0. pH value of 6.5-9.0 enhances good growth; pH value of 4.0-6.5 or 9.0-11.0 makes fish grow slowly, and at pH value <4.0 or >11.0 makes fish die. Dissolved oxygen also fluctuated between 3 to 9 mg/L. Morning oxygen was low, but in the afternoon, towards the afternoon, oxygen was relatively high. The results of Makori et al. (2017) research on tilapia culture ponds showed a dissolved oxygen range of 5-23 mg/L. According to Djarijah (1995), good dissolved oxygen for tilapia culture is more than 5 mg/L. The fluctuated and low dissolved oxygen will cause disruption of fish growth and metabolism (Boyd, 1990; Makori et al., 2017). In addition, temperature, pH and dissolved oxygen that is not optimal will increase the toxicity of other parameters (Moore and Ramamoorthy, 2012), in this case, ammonia (NH_3) and Fe. This causes disruption of fish growth and feed conversion efficiency.

The concentration of ammonia (NH_3) showed a range of 0.03-12.80 mg/L. The highest fluctuations were found in treatment A, while the lowest values and ranges were found in treatment B. Ammonia concentration was low at the beginning of the experiment and high at the end of the experiment. According to Djarijah (1995), the concentration of ammonia (NH_3) <0.02 mg/L is good for tilapia culture. According to Amri and Khairuman (2008), the concentration of ammonia in water should not exceed 1 mg/L. The high concentration of ammonia was thought to come from fish faeces and leftover feed in the treatment tanks. The concentration of Fe in water from ex-sand pit lakes in Pasir Sakti Sub-district is relatively high (Firdaus, 2012; Malik, 2017; Hasani et al., 2021b), reaching 0.22-1.54 mg/L (Fisheries and

Marine Affairs Services of Lampung Province, 2017), even according to Hasani et al. (2021a) the concentration reached 0.15-5.89 mg/L. Phytoremediation experiments using *E. crassiper, A. pinnata* and *S. molesta* in this study have succeeded in reducing the Fe concentration to less than 0.03 mg/L, which is a reasonable value for fish culture (Krismono et al. 1998). The lowest Fe concentration as the initial value of this study was obtained in treatment B (0.01 mg/L), while treatments C and D were each 0.02 mg/L. Treatment A without aquatic plants showed the highest Fe concentration of 1.10 mg/L. During the rearing of tilapia, the concentration of Fe increased consistently until the end of the treatment with values of 2.23 mg/L (treatment A), 0.41 mg/L (treatment B), 0.53 mg/L (treatment C) and 0.57 mg/L (treatment D).

Table 1. Water quality range in each treatment tank.

Parameters	**Treatments**			
	A	**B**	**C**	**D**
Temperature (°C)	28-32	29-33	29-33	28-32
pH	6.6-8.4	4.2-7.2	5-8.7	4.7-8.9
Dissolves Oxygen (mg/L)	3-7	3-8	4-8	3-9
Amonia (mg/L)	0.03-12.80	0.51-3.59	0.14-4.15	0.54-5.23
Fe (mg/L)	1.10-2.32	0.01-0.41	0.02-0.53	0.02-0.57

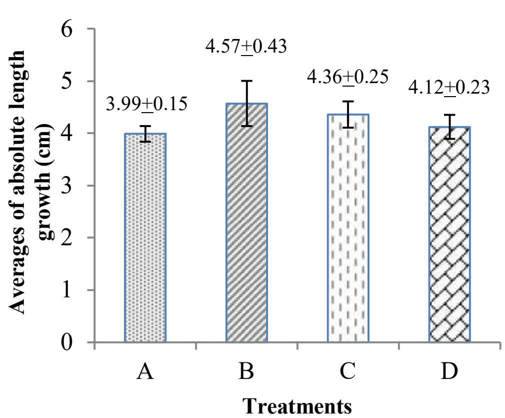
Absolute length and absolute weight growth gain

The range of absolute length and absolute weight gains also showed the same trend. Tilapia cultured in treatment B obtained the highest absolute length gain in the range of 3.85-5.30 cm, while tilapia cultured in treatment A showed the lowest length growth in the range of 3.84-4.14 cm. The absolute weight growth range data also showed the same trend. Tilapia cultured in treatment B obtained the highest absolute weight gain in the range of 5.67-7.01 g, while tilapia cultured in treatment A showed the lowest weight growth in the range of 4.37-4.59 g (Table 2). The average growth of fish length during 40 days of culture ranged from 3.99 cm to 4.57 cm, or from 0.09 to 0.11 cm/day. The highest results were obtained in treatment B and the lowest in treatment A. The ANOVA test at the 95% confidence level showed that the average growth of fish length in treatment A was not significantly different from treatment D, but it was significantly different with B and C. Meanwhile, treatment B was not significantly different from treatment C. The average absolute weight growth showed differences between treatments except for treatment A and treatment D (Figure 1).

Table 2. Range of absolute length and absolute weight growth of tilapia in each treatment.

Treatments	**Absolute length growth (cm)**	**Absolute weight growth (g)**
A	3.84-4.14	4.37-4.59
B	3.85-5.30	5.67-7.01
C	4.11-4.61	4.88-6.04
D	3.67-4.57	4.45-5.75

The growth in length of tilapia in this study was lower than the results of Arifin (2016) that the growth of red tilapia for 60 days of culture reached 15.35cm or 0.26 cm/day; while black tilapia reached 10.61 cm or 0.18 cm/day.



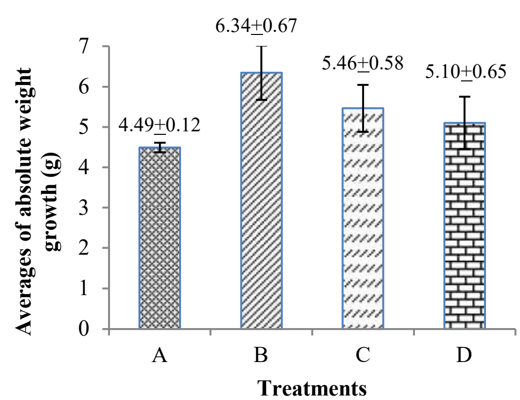


Figure 1. Average growth in length and absolute weight of tilapia.
Note: The same letters in the histogram show no significant difference between treatments at the 95% confidence level.

The results of this study were also lower than the growth of Gift tilapia in Kunduchi, Tanzania, which reached 1.92 ± 0.40- 3.67 ± 0.40 cm/day; also tilapia gift strain silver YY in Pangani Tanzania, whose length growth reached 2.48 ± 0.40, 4.54 ± 0.40 (Moses et al., 2001). Another study by Attee et al. (2017) examined the growth of tilapia in the Tigris River, Baghdad, in the first year of life, increased by 81.02 mm or 0.81 cm. The growth of tilapia in this study was low. The fluctuating pH value of 4.2-8.9 (Table 1) is a relatively wide range for the growth of tilapia. According to Boyd (1984), a good pH value for tilapia growth is 6.5-9.0. The pH values of 4.0-6.5 and 9.0-11.0 cause fish growth to be slow. Low oxygen concentrations in the morning (3-4 mg/L) have disrupted fish metabolism (Boyd, 1984) and caused slow fish growth (Boyd, 1984; Makori et al., 2017). A good level of oxygen for the growth of tilapia is >5mg/L (Djarijah, 1995). However, the results of this study are higher than that of Makori et al. (2017), that the growth in total length of tilapia cultured in soil ponds was almost uniform, increasing steadily from < 5cm to more than 12 cm on 112 days. The results of the study by Medri *et al*. (2000) found the fact that the growth of tilapia ranged from 0.056 to 0.082 cm/day.

The average absolute weight growth was 4.49-6.34 g or 0.11-0.16 g/day (Figure 1). The highest value was obtained in Treatment B, and the lowest was in Treatment A. This value was low when compared to the growth of fish research by Kohinoor et al. (1999); the weight growth of red tilapia was 0.53-1.37 g/day, while the growth of black tilapia was 0.42-1.20 g/day. According to Makori et al. (2017) growth of tilapia 0.1692 g/day-1.9 g/day. According to Adria (2010), the growth of tilapia reaches 0.78-1.09 g/day. In a study by Trinth et al. (2021), for 120 days of culture, the growth of Gift tilapia reached 1.25 g/day, AKOC tilapia 0.56 g/day, and AKOS strain 0.71 g/day. However, the growth yield of tilapia in this study was higher than that of Medri et al. (2000); with various yeast treatments at the age of up to 1 month, the growth of tilapia could reach 0.07-0.12 g/day. The growth of absolute length and absolute weight of tilapia in this study was lower than that of tilapia cultured in other studies, for example (Kohinoor et al., 1999; Moses et al., 2001; Attee et al., 2001; Makori et al., 2017; Trinth et al., 2021). In this study, the commercial feed was used with a minimum protein content of 39-41%, minimum fat 5%, maximum fiber 6%, maximum ash 18% and maximum water 10%. Feeding intervals were three times a day, namely at 07:00, 13:00 and 17:00 western Indonesian time. Feeds with such good content can be considered sufficient to stimulate fish growth (Barrows and Hardy, 2001; Adria, 2010; Fran et al., 2011). Poor water quality with high Fe concentration is thought to be a factor responsible for the low growth of tilapia cultured in water from ex-sand pit lakes. Poor water quality affects the level of efficiency and effectiveness in the use of feed for fish growth (Fran et al., 2011). According to Sahetapy (2011), heavy metals can also inhibit the growth rate of fish. Heavy metals in the body with high concentrations will inhibit enzyme activity. Enzymes work significantly reduced or do not work at all (Palar, 2002).

Survival rate of Tilapia

Survival rate (SR) is the percentage of living organisms at the end of culture (Yulianti et al., 2003). The average SR of tilapia in this study was quite uniform between treatments, ranging from 98.08% to 99.08%. The lowest was in treatment B, and the highest was in treatment C (Figure 2).

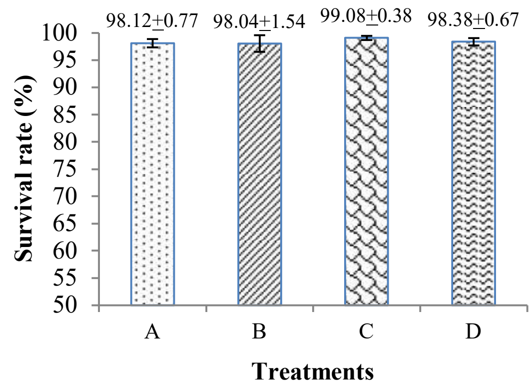


Figure 2. Tilapia survival rate by the treatments.

Based on the ANOVA test with a confidence level of 5%, the SR of tilapia showed no significant difference (P < 0.5). The SR of tilapia cultured in water from ex-sand pit lakes with phytoremediation treatment in this study was relatively high compared to several previous studies. Azaza et al. (2008) stated that the survival rate of tilapia (*O. niloticus* L.) fed a diet containing green algae ulva flour (*Ulva rigida*) in Southern Tunisia ranged between 91.11 and 93.33%. Adria (2010) stated that the growth of red tilapia with various treatments reached 89%-93%. According to Mulyani et al. (2014), the SR of tilapia (*O. niloticus*), which was periodically fasted, reached 85.00%-93.33%. This illustrates that tilapia cultured in ex-sand pit lakes water after phytoremediation treatment can survive, although its growth is low. According to Boyd (1984), fish will slow to grow at pH 4-6.5 or 9-11. At pH <4 or >11 fish can die. The pH in the experimental tanks of this research is 4.2-8.9. This condition has caused slow fish growth but did not cause death. The concentration of Fe, which increased again after phytoremediation treatment also played a role in this. Fe can enter the fish body through the gills or through food and will accumulate in the kidneys. Fish can absorb dissolved iron from water through the gills (Herliyanto et al., 2014) or through the fins and skin (Tambunan and Nainggolan, 2013). Fe deficiency can cause anaemia in fish, low feed conversion, decreased appetite and abnormalities. However, excess Fe also causes gastrointestinal distress (digestive tract disease) in fish so that their growth is disrupted (Tambunan and Nainggolan, 2013). However, the value of Fe concentration in experimental tanks did not cause mass deaths of fish. According to Trinh et al. (2021), the growth of tilapia fed pelleted feed with a protein content (crude protein pelleted feed) of 38% and feeding twice a day with an amount of 5% of the body weight of fish can produce an SR level of 80.2% for gift tilapia, and 95.7% for tilapia strain Akos, for 120 days of culture. This SR value indicates that differences in water quality and Fe concentration in water from ex-sand pit lakes affected fish growth, but not to the point of causing fish death. In addition, the high SR value of this tilapia, because it was a young tilapia. This is in line with the research results of Mundriyanto et al. (1994), that the growth of tilapia with various feeding methods resulted in SR of 100% at week 1-3, decreased to 99.20-99.87% at 6th week; and continued to decline to 93.07-93.79% in the 15th week. Feed quality, frequency of feeding, and percentage of feed to weight also affect SR. The Srikandi strain tilapia cultured by feeding three times a day with a feed percentage of 1%-2% of the fish weight resulted in an SR of 27.55% for a feed with protein of 23.4% and an SR of 24.22% for a diet with protein. 12.8%, for 4 months of culture (Sinansari et al., 2019).

Feed conversion ratio

Feed conversion ratio (FCR) is the ratio of the amount of feed needed to produce fish meat (USAID, 2011). The smaller the FCR value, the better indication of high-quality feed (USAID, 2011; Iskandar and Elrifadah, 2015). In this study, the best FCR was in treatment B of 1.18±0.67, and the worst was in treatment A, which was 1.40±0.54 (Figure 3). This means that to produce one kilogram of fish meat, 1.18 kg of feed is needed in treatment B, and 1.40 kg in treatment A. According to Anggraini et al. (2020), the FCR of saline tilapia (*O. niloticus*, Linn) fed with 31-33% protein resulted in an FCR of 2.11 for feeding 6% body weight, FCR of 2.16 for feeding by 7% of body weight, and FCR of 0.21 for feeding 8% of body weight. Azaza et al. (2008), stated that the FCR of tilapia (*O. niloticus* L.) fed a diet containing flour content of green algae ulva (*Ulva rigida*) in Southern Tunisia ranged from 1.73±0.08 to 2.57±0.07. The results of the research by Mundriyanto et al. (1994), that tilapia culture with different feeding methods resulted in FCR ranging from 2.79±0.12 to 2.73±0.12 for 18 weeks of culture. Tilapia (*O. niloticus*) cultivated in an aquaponic system using romaine watercress (*Lactuca sativa* L. var. longifolia), resulted in weight growth reaching 3.96 ± 0.44 g/day, SR of 96.1 ±1.44% and, and FCR of 1.60 ± 0.07 (Effendi et al., 2017). According to Barrows and Hardy (2001), FCR value is influenced by feed nutrition. Protein feed that is in accordance with the nutritional needs of fish will result in more efficient feeding. The increase in Fe concentration in each experimental tank was responsible for the low growth of fish and FCR in this study. The high concentration of Fe causes disruption of osmoregulation in the gills (Yulaipi and Aunurohim, 2013).

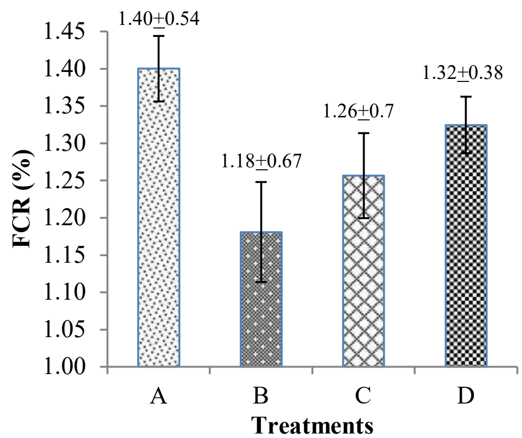


Figure 3. Feed conversion ratio for each treatment.

Excessive concentrations of Fe and other heavy metals also cause disruption of the metabolic function of fish, thereby reducing the rate of feed conversion (FCR), which ultimately interferes with fish growth (Purnomo and Muchyiddin, 2007; Yulaipi and Aunurohim, 2013). The high concentration of Fe that enters the body of fish can also interfere with the function of the enzymes Delta Aminolevulinic Acid (delta-ALA) and Ferrochelatase (Landis et al., 2011). This condition results in disruption of the metabolic process of fish and ultimately interferes with fish growth (Purnomo and Muchyiddin, 2007; Landis et al., 2011). High concentrations of Ammonia (NH_3) also cause disruption of fish growth and feed conversion ratio (Moore and Ramamoorthy, 1984; Khoiruman and Amri, 2005)

The increase in Fe concentration in each experimental tank was caused by changes in water quality. According to Khatri et al. (2017), Fe in water can be in the form of dissolved ferrous (Fe^{2+}) and insoluble ferric (Fe^{3+}). Environmental factors such as pH (Endrawati and Supriyantini, 2015; Khatri et al., 2017), and dissolved oxygen (Rochyatun and Rozak, 2007; Khatri et al., 2017), also affect the solubility of Fe in water. High temperatures can reduce the solubility of oxygen in water (Endrawati and Supriyantini, 2015), while low oxygen and pH can cause changes in the form of insoluble iron (Fe^{3+}), to form dissolved iron (Fe^{2+}) (Endrawati and Supriyantini, 2015; Khatri et al., 2017). This condition causes the dissolved Fe concentration in each experimental tank to increase. Increasing the concentration of Fe in the waters will cause disruption of fish metabolism so that fish growth is disrupted, although not to the point of causing fish death. This condition causes the growth of tilapia in this study to be low but the SR value remains high.

Conclusion

Phytoremediation of water from ex-sand pit lakes using *E. crassipes, A. pinnata* and *S. molesta*, has succeeded in reducing the Fe concentration to a value suitable for tilapia culture. Experimental culture of red tilapia with phytoremediated water media without water change and aeration has caused fluctuations in water quality. The decrease in pH and dissolved oxygen causes a change in the form of insoluble Fe to dissolved Fe in water so that the Fe concentration increases again. Changes in water quality and an increase in Fe concentration have disrupted the metabolism of tilapia. Disruption of fish metabolism causes the conversion of feed into fish meat low, and ultimately the growth in length and weight of fish is also low. However, water quality does not cause fish mortality to be high. Therefore, it is recommended to cultivate tilapia using additional aeration and to change water by preparing remedied water reservoirs to maintain water quality for better growth of fish length and weight. It is also necessary to research the culture of other fish species to find the most suitable fish species to be cultured in phytoremediated water. The type of fish with the best SR and growth can be recommended to the community to be cultivated with tarpaulin ponds and remediation treatment.

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