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Research Paper

Comparison of Tilapia Fish Pond Wastewater Treatment to Clean Water with Wetlands and Vetiver Phytoremediation on Fe and Odor

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ABSTRACT
Greywater, a type of wastewater derived from tilapia pond feces, requires proper processing before being discharged into the river. Thus far, graywater waste treatment is discharged directly into the river. This research aims to increase the effectiveness of wastewater treatment by using a physical model consisting of 2 treatment processes including wetland and phytoremediation.
This research applied the phytoremediation method and vetiver wetlands (Vetiveria zizanoides). The research variables observed were variations in wastewater discharge (X1), the number of vetiver stems (X2), wetlands residence time (X3) at intervals of 2 days, 4 days and 7 days, and water quality parameters (Y) consisting of Fe and Odor. The data analysis method used is Linear Regression with the help of the SPSS program. According to the findings of the research, the quality of waste water from tilapia fish ponds treated with vetiver is determined by the Fe parameter (iron 0.2 mg/L), which can decrease phytoremediation by up to 69% and Fe wetlands by up to 68%. In phytoremediation, the odor parameter (odorless) can be reduced by up to 92%, while in wetlands it can be reduced by up to 61.5 percent.
Thus, overall it can be concluded that the use of the physical model of sewage treatment applied is able to reduce the pollutants contained in graywater waste of tilapia pond water.

Keywords: *Wastewater Treatment, Phytoremediation, Clean water*

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I. Introduction

Domestic waste ranks first as one of the largest sources of pollutants for aquatic environments, especially rivers [1]. This pollutant load contaminates up to around 57% of river flow [2, 3]. Meanwhile, river water itself should still be able to be used for various purposes, such as for agricultural and gardening irrigation needs, washing vehicles and tools, and so on [4, 5, 6, 7]. Domestic waste reduces the benefits of river water, where river water can have negative impacts if used, such as disrupting the quality of plant growth if used for irrigation, and so on [8, 9, 10, 11].

Given the high production of domestic wastewater, as well as its high potential for pollution, the topic of waste processing will always be needed as one of the solutions that can be attempted. Various previous studies have formulated various waste processing technologies that are easy to apply and have the potential to produce optimal output through various approaches [2, 3, 4, 5, 11]. One approach that is currently being widely developed is the use of aquatic plants as phytoremediators [12, 13]. Waste processing media equipped with aquatic plants are not only able to precipitate or filter pollutants, but can also perfect the processing process because pollutants are absorbed by plant roots [14].

Vetiver grass (Vetiveria zizanioides), or locally known as Akar wangi grass, is a type of aquatic plant that has grown wild so that it is very easy to find [15]. The potential of vetiver grass is not only used as handicrafts and ornamental plants, but can also be used as a wastewater remediator agent [16, 17]. This potential has been proven by various studies [18]. This potential can be a very good solution for the fulfillment of clean water, especially in urban areas.

II. MATERIALS AND METHODS

2.1 Conceptual Framework

Tilapia pond wastewater treatment and its output is processed into clean water to improve water quality so that it can be reused. To provide a clear picture of how the variables in this study interact with each other, a conceptual framework of the study is made based on the background, problems and objectives of the study; background, problems and objectives of the study.

The variables in this study include the following:

1) Free Variables:

a. Length of residence time (2 days, 4 days, 7 days or more)

Each is distinguished based on the type of plant used in the wetland, namely Vetiveria zizanoides with media and without media.

2) Teh dependent variables consists of selected parameters, which are as follows:

a. Ion (Fe)

b. Odor

As for the quality standards of each parameter above referring to the Minister of Health Regulation No. 2 of 2023 concerning Hygiene and sanitation (clean water), the Research Parameters are described as follows:

Research Parameters are described as follows:

No	Parameter	Clean water Standard	Unit
1.	Odor	Odorless	
2.	Iron (Fe)	0,2	Mg/L

Source: Government Regulation of the Republic of Indonesia Number 2 of 2023 concerning Hygiene and sanitation.

2,2. Reaseach Hypothesis

The hypothesis to be proven in this study is as follows:

- ➢ The filter material used has a significant effect on the quality of treated wastewater.
- ➢ The use of a wetland system by utilizing vetiver plants provides better wastewater treatment results based on the number of stems used.
- ➢ Length of residence time has a significant effect on the quality of treated wastewater, especially in the filtration process using wetland
- ➢ The physical model of sewage treatment is able to improve the quality of wastewater to meet clean water criteria and debit variations.

2.3. Operasional Definition

- ➢ A physical model is an imitation of a natural event or a prototype in the field that is formed using a physical model in the laboratory.
- ➢ Grey water is the colored waste water of tilapia ponds that comes from the output of the pond which is directly disposed into the river.
- ➢ A filter is a material used to improve the quality of waste water before it is disposed of.
- ➢ Constructed wetland is an artificial wetland planted with aquatic plants as a wastewater remediation agent. Wetlands are made in two kinds, namely those planted with Vetiver Root (Vetiveria zizanioides) as a phytoremediation agent for graywater waste.

2.4. Planning of Building Model

Technical Specificantion Model: The building model is designed using a scale ratio of 1: 100, with a discharge scale. For the wetland, 2 boxes were made with the aim of comparing between the two media, namely vetiver plants (Vetiveria zizanioides) with media and without media. The box has a size (70 x 30 x 30 cm) of 2 pieces for vetiver plants. In this physical model using waste discharge taken from the output of the fish pond so that the actual debit is also modeled because it adjusts the conditions of the existing laboratory site.

Technical Specifications Model: Materials:

- Plastic material of hand washing sink
- Estimator glass (to observe the water level)
- Faucet with a diameter of ¾ "

Figure 1: Phytoremidiation box, Figure 2: Wetland box with media, Figure 3: Phytoremediation and wetlands complete with plants.

III. RESULTS AND DISCUSSION

3.1. Phytoremediation (without media)

Parameter Fe (Iron)

Tabel 2. Results of Greywater treatment with Fe Phytoremediation (Standard 0.2 mg/L)

Number of stems AW	Water Debit (liters/day)	Greywater	Time		
			2 days	4 days	7 days
50	1000 liters/day	0,0585	0,0665	0,0867	0,0248
	1500 liters/day	0,0585	0,0678	0,0902	0,0248
	2000 liters/day	0,0585	0,0685	0,0910	0,0236
100	1000 liters/day	0,0585	0,0718	0,0928	0,0263
	1500 liters/day	0,0585	0,0725	0,0918	0,0252
	2000 liters/day	0,0585	0,0689	0,0909	0,0271
150	1000 liters/day	0,0585	0,0676	0,0202	0,0181
	1500 liters/day	0,0585	0,0676	0,0299	0,0184
	2000 liters/day	0,0585	0,0691	0,0211	0,0181

Source: Calculation result

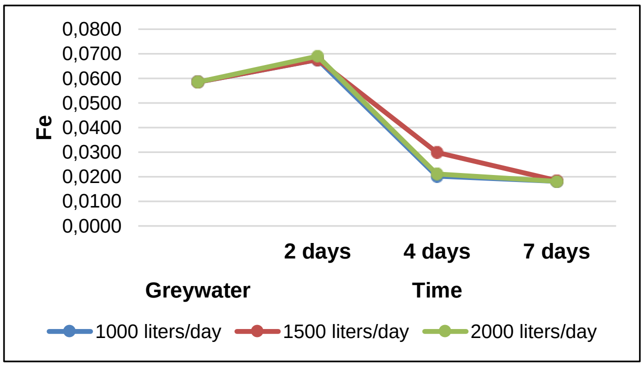

Figure 4: Fe Graph Based on Water Discharge and Residence Time with 150 Stems

The results of the Fe parameter description showed that with the number of vetiver stems as many as 150 stems and each addition of water discharge at different residence times would be able to reduce the Fe value.

Table . Factors and their response according to F-CCCD for the two fan types

Tabel 3. Results of Greywater wtreatment with phytoremediation Odor (Standard Odorless)

number of stems AW	Debit Air (liters/day)	Greywater	Time		
			2 days	**4 days**	**7 days**
50	1000 liters/day	2	1,50	0,75	0,20
	1500 liters/day	2	1,55	0,74	0,19
	2000 liters/day	2	1,47	0,74	0,21
100	1000 liters/day	2	1,41	0,71	0,18
	1500 liters/day	2	1,48	0,75	0,19
	2000 liters/day	2	1,48	0,68	0,17
150	1000 liters/day	2	1,28	0,66	0,17
	1500 liters/day	2	1,24	0,68	0,16
	2000 liters/day	2	1,30	0,68	0,16

Source: Calculation Result

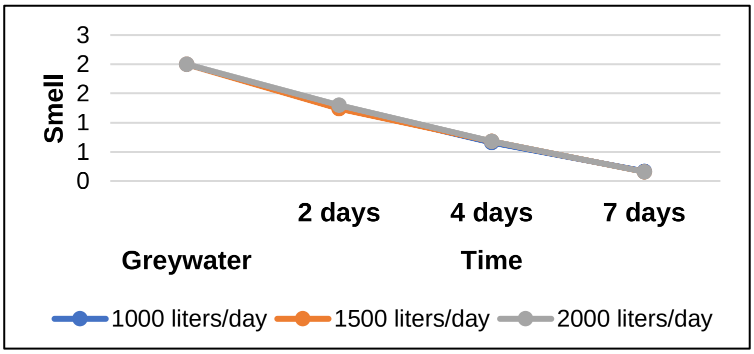

Figure 5: Odor Chart Based on Water Discharge and Residence Time with 150 Stems

The results of the odor parameter description showed that with the number of vetiver stems as many as 150 stems and each addition of water discharge at different residence times would be able to reduce the odor value.

4.2. Using Wetlands (Submerged Soil Media)
Parameter Fe (Iron)

Table 4. Results of Greywater waste treatment with Wetlands Fe (Standard 0.2 mg/L)

Number of Stems AW	Water Debit (litre/day)	Greywater	Time		
			2 days	**4 days**	**7 days**
50	1000 liters/day	0,0585	0,0432	0,0325	0,0260
	1500 liters/day	0,0585	0,0454	0,0312	0,0255
	2000 liters/day	0,0585	0,0432	0,0309	0,0265
100	1000 liters/day	0,0585	0,0471	0,0351	0,0276
	1500 liters/day	0,0585	0,0461	0,0344	0,0273
	2000 liters/day	0,0585	0,0494	0,0362	0,0265
150	1000 liters/day	0,0585	0,0299	0,0186	0,0189
	1500 liters/day	0,0585	0,0294	0,0194	0,0186
	2000 liters/day	0,0585	0,0219	0,0175	0,0104

Source: Calculation result

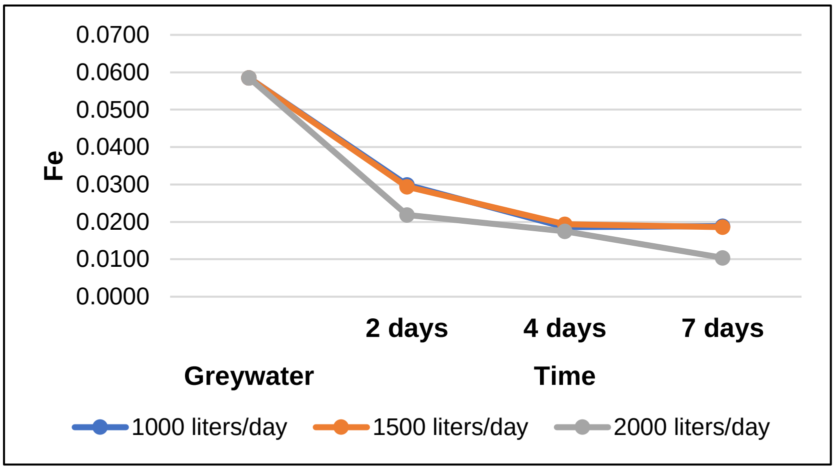

Figure 6 : Fe Graph Based on Water Discharge and Residence times with 150 Stems

The results of the odor parameter description show that with the number of vetiver stems as many as 150 stems and each addition of water discharge at different residence residence times will be able to reduce the odor value.

Statistical Analysis
This section presents the results of testing the effect of water discharge, number of vetiver stems, and residence time on water quality parameters including Fe and odor

Table 5: Summary of Linear Regression Test Results on Fe Phytoremediation

No	Free Variable	Coef	p	R Square
1	Constant	0.064	0.007	0.00%
	Water Debit(X1)	$1.778x10^{-7}$	0.990	
$Y = 0.064 + 1.778x10^{-7}$ X1 + e				
2	Constant	0.056	0.001	1.50%
	Number of stem (X2)	0.0001	0.543	
Y = 0.056 + 0.0001 X2 + e				
3	Constant	0.109	0.000	54.64%
	Residence time (X3)	-0.010	0.000	
	Y = 0.109 - 0.010 X3 + e			
4	Constant	0.100	0.000	56.15%
	Water Debit (X1)	$1.778x10^{-7}$	0.985	
	Number of Stem (X2)	0.0001	0.384	
	Residence time (X3)	-0.010	0.000	
	$Y = 0.100 + 1.778x10^{-7}$ X1 + 0.0001 X2 - 0.010 X3 + e			

The effect of water discharge on Fe shows a positive but insignificant effect with a regression coefficient of 1.778x10-7 and a significance value (p) of 0.990 (p> 0.05), meaning that the greater the amount of water discharge will affect the higher Fe, with the addition of water discharge of 1 liter / day will increase the Fe value by 1.778x10-7 units.

Table 6: Summary of Linear Regression Test Results on Fe Wetlands

No	Free Variabel	Coef	p	R Square
1	Constant	0.036	0.000	0.04%
	Water Debit (X1)	$4.000x10^{-7}$	0.925	
$Y = 0.036 + 4.000x10^{-7}$ X1 + e				
2	Constant	0.031	0.000	7.10%
	Number of Stems (X2)	0.0001	0.179	
Y = 0.031 + 0.0001 X2 + e				
3	Constant	0.053	0.000	85.72%
	Residence time (X3)	-0.004	0.000	
Y = 0.053 - 0.004 X3 + e				
4	Constant	0.047	0.000	92.86%
	Water Debit (X1)	$4.000x10^{-7}$	0.735	
	Number of Stems (X2)	0.0001	0.000	
	Residence time (X3)	-0.004	0.000	
$Y = 0.047 + 4.000x10^{-7}$ X1 + 0.000 X2 - 0.004 X3 + e				

The effect of water discharge on Fe shows a positive but insignificant effect with a regression coefficient of -1.333x10-6 and a significance value (p) of 0.925 (p> 0.05), meaning that the greater the amount of water discharge will affect the higher Fe, with the addition of water discharge of 1 liter / day will increase the Fe value by 1.333x10-6 units.

Tabel 7: Summary of Linear Regression Test Results on Phytoremediation Odor

No	Free Variable	Coef	p	R Square
1	Constant	0.763	0.060	0.00%
	Water Debit (X1)	$3,333x10^{-6}$	0.989	
$Y = 0.763 + 3,333x10^{-6}$ X1 + e				
2	Constant	0.881	0.003	0.83%
	Number of Stems (X2)	-0.001	0.652	
	Y - 0.881 - 0.001 X2 + e			
3	Constant	1.811	0.000	94.67%
	Residence Time(X3)	-0.241	0.000	
	Y = 1.811 - 0.241 X3 + e			
4	Constant	1.919	0.000	95.49%
	Water Debit (X1)	$3,333x10^{-6}$	0.952	
	Number of Stems (X2)	-0.001	0.051	
	Residence Time (X3)	-0.241	0.000	
	$Y = 1.919 + 3,333x10^{-6}$ X1 - 0.001 X2 - 0.241 X3 + e			

The effect of water discharge on odor shows a negative but insignificant effect with a regression coefficient of 3.333x10-6 and a significance value (p) of 0.989 (p> 0.05), meaning that the greater the amount of water discharge will affect the lower the odor, with the addition of water discharge of 1 liter / day will reduce the odor value by 3.333x10-6 units.

Table 8: Summary of Linear Regression Test Results on Odor

No	Free Variable	Coef	p	R Square
1	Constant	1.565	0.000	0.01%
	Water Debit (X1)	-0.00001	0.966	
	Y = 1.565 - 0.00001 X1 + e			
2	Constant	1.808	0.000	5.02%
	Number of Stems (X2)	-0.003	0.261	
	Y = 1.808 - 0.003 X2 + e			
3	Constant	2.413	0.000	75.81%
	Residence Time (X3)	-0.199	0.000	
	Y = 2.413 - 0.199 X3 + e			
4	Constant	2.686	0.000	80.84%
	Water Debit (X1)	0.000	0.925	
	Number of Stems (X2)	-0.003	0.022	
	Residence time (X3)	-0.199	0.000	
	Y = 2.686 - 0.00001 X1 - 0.003 X2 - 0.199 X3 + e			

The effect of water debit on odor shows a negative but insignificant effect with a regression coefficient of -0.00001 and a significance value (p) of 0.966 (p> 0.05), meaning that the greater the amount of water discharge will affect the lower the odor, with the addition of water discharge of 1 liter / day will reduce the odor value by 0.00001 units.

IV. CONCLUSION

Based on the findings of the research, it can be concluded that the Fe parameter (iron 0.2 mg/L) determines the quality of waste water from tilapia fish ponds treated with vetiver; specifically, phytoremediation can reduce the water quality by up to 69% and Fe wetlands by up to 68%. In phytoremediation, the odor parameter (odorless) can drop by up to 92%, and in wetlands, it can drop by up to 61.5%.

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