The Effectiveness Comparison of Type of Treatments in Decreasing of Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) in Household Wastewater

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Abstract

Context: In Indonesia, the biggest source of wastewater producers comes from household activities. phytoremediation and biofiltration are some method that can handle domestic wastewater pollution. This study aims to determine the effectiveness comparison of the type of treatments in decreasing of TDS and TSS in Household Wastewater. The research method used in this research is pure experiment. The sample selection is based on the level of pollution that occurs in the ternate city area due to wastewater and has a high population density so that it is taken a sample in the eastern Makassar district. Media selection is based on its ability to reduce pollutant parameters of TDS and TSS as has been stated in several journals with biofiltration and phytoremediation approaches. The total sample used was 15 liters of domestic wastewater. This research was conducted for 4 weeks and all parameter was tested 4 times, the first test was at the first week, the second test was after treatment second weeks, the third test was after treatment 3rd week, the fourth test was after treatment 4th week. All tested parameter tests by using the gravimetry method. Phytoremediation by using water hyacinth is more effective in reducing levels of TDS and TSS in domestic waste than biofiltration by using banana stems.

Keywords: Phytoremediation, biofiltration, total dissolved solid, total suspended solid.

Introduction

World Health Organization estimates, that up to 80% of illnesses and infections in the world result from inadequate treatment of sewage and thus insufficient amount of clean water. WHO also reports that more than 3.4 million people die annually due to the activity of pathogens living in the aquatic environment(1). It can be said that water is a key component of socio-economic development and keeps the environment in good condition(2).

A modern WWTP must fulfill several basic tasks. Besides the effective removal of contaminants from the influent sewage, the reduction of greenhouse gases emission, energy-saving and the ability to reuse the part of resources such as the agricultural use of sewage sludge, must also be taken into account(3). The untreated or insufficiently treated wastewater is a direct threat to the environment. Moreover, a discharge of untreated sewage into the receiving water body causes severe contamination resulting in eutrophication and intoxication of the aquatic organisms, as well as the chemical and biochemical transformations of pollutants causing the release of harmful gases disturbing the functioning of the ecosystems. All these factors cause a change in the biotic conditions and the physicochemical composition of wastewater receiver(4-7).

The problem of environmental pollution, especially water pollution in Indonesia, has shown quite serious symptoms. One of the causes of water pollution comes from factory industrial discharges or other activities that
simply dispose of wastewater without prior treatment into the river or the sea\(^{(8)}\). The amount of water pollution in North Maluku increased by 370 percent, compared to 2014. Analysis of the Domestic Wastewater Risk Index in Ternate City in 4 sub-districts, shows that the existing Domestic Wastewater needs serious attention considering the insecure septic tank coverage of 60%\(^{+}\), the scope of pollution due to disposal of contents Unsafe Septic Tanks are in the range of 21.4-65.9\% and Pollution coverage due to SPAL is 50%\(^{+}\) except for strata 0 of 12.5\%. This will harm the quality of the surrounding environment, especially Clean Water Sources\(^{(9)}\).

Phytoremediation involves the use of plants to remove, transfer, stabilize and/or degrade contaminants in soil, sediment, and water. This plant-based technology has gained acceptance in the past ten years as a cheap, efficient and environmentally friendly technology especially for removing toxic metals\(^{(10)}\). Biofiltration is a process in which an otherwise conventional granular filter is designed to remove not only fine particulates but also dissolved organic compounds through microbial degradation. Technologies that can be used to remove pollutants include flocculation, adsorption, (bio)filtration, ion exchange, (advanced) oxidation processes and membrane filtration\(^{(11)}\).

This study aims to determine the effectiveness comparison of the type of treatments in decreasing of TDS and TSS in Household Wastewater.

**Material and Method**

Laundry wastewater sampling by taking a combined sample of time (morning, afternoon and evening) and place (5 places in RT 01) by taking samples of 1000 ml per one take. For instance, the sample was 15000 ml of wastewater. The method of measuring TDS and TSS uses the gravimetric method in which Gravimetry is one of the quantitative analysis method of a substance or component that has been known by measuring the weight of the component in a pure state after going through a separation process. The biggest part of the gravimetric analysis involves the transformation of elements or radicals into pure stable compounds that can be immediately converted into meticulously weighed forms\(^{(12)}\).

**TDS calculation**

\[
\text{TDS} = \frac{1000}{V} \times (F - B) \times 1000 = \ldots \text{mg/L}
\]

**Information:**

\[
B = \text{weight of the Vaporizer Cup (g)}
\]

\[
F = \text{weight of the Vaporizer Cup + dissolved residue (g)}
\]

**TSS Calculation**

\[
\text{TSS} = \frac{1000}{V} \times \{G \times (C+D)\} \times 1000 = \ldots \text{mg/L}
\]

**Information:**

\[
C = \text{weight of the Vaporizer Cup (g)}
\]

\[
D = \text{Filter Paper weight (g)}
\]

\[
G = \text{weight of the Vaporizer Cup + filter paper filter (g)}
\]

The sample selection is based on the level of pollution that occurs in the ternate city area due to wastewater and has a high population density so that it is taken a sample in the eastern Makassar district. Media selection is based on its ability to reduce pollutant parameters of TDS and TSS as has been stated in several journals with biofiltration and phytoremediation approaches.

The number of samples taken is adjusted to the needs of research where the number of samples taken based on the place and the combined time can be accumulated as much as 15000 ml. Number of places x amount of time x liters per take 5x3x1000 ml=15000 ml. The research was carried out for 4 weeks by looking at the effectiveness of bioreactors made by conducting tests on the first week to the fourth day. The research method used in this research is pure experiment. The total sample used was 15 liters of domestic wastewater. This research was conducted for 4 weeks and all parameter was tested 4 times.

Phytoremediation processes rely on the ability of plants to take up and/or metabolize pollutants to less toxic substances\(^{(13)}\). The main purpose of the biofilter is to remove the dissolved organics, the suspended particles are removed in conventional filter before subjecting the wastewater\(^{(14)}\).

**Findings:**

Based on the results of research conducted in the Chemical Laboratory, Environmental Health department, Health Polytechnic of Ternate can be seen in the following table 1.
Table 1: The result of TDS and TSS tests on two media in 4 weeks

<table>
<thead>
<tr>
<th>TDS</th>
<th>TSS</th>
<th>Unit</th>
<th>Week</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>625</td>
<td>475</td>
<td>Mg/l</td>
<td>1</td>
<td>Phytoremediation</td>
</tr>
<tr>
<td>665</td>
<td>563</td>
<td>Mg/l</td>
<td>2</td>
<td>Phytoremediation</td>
</tr>
<tr>
<td>485</td>
<td>450</td>
<td>Mg/l</td>
<td>3</td>
<td>Phytoremediation</td>
</tr>
<tr>
<td>311</td>
<td>417</td>
<td>Mg/l</td>
<td>4</td>
<td>Phytoremediation</td>
</tr>
<tr>
<td>625</td>
<td>475</td>
<td>Mg/l</td>
<td>1</td>
<td>Biofiltration</td>
</tr>
<tr>
<td>563</td>
<td>418</td>
<td>Mg/l</td>
<td>2</td>
<td>Biofiltration</td>
</tr>
<tr>
<td>525</td>
<td>480</td>
<td>Mg/l</td>
<td>3</td>
<td>Biofiltration</td>
</tr>
<tr>
<td>755</td>
<td>417</td>
<td>Mg/l</td>
<td>4</td>
<td>Biofiltration</td>
</tr>
</tbody>
</table>

Information: TDS= Total Dissolved Solid, TSS= Total Suspended Solid

Discussions

Based on the results of the treatment for 4 weeks the results obtained are the first examination on the sample of wastewater before treatment with water hyacinth (Eichhornia) and banana stems (Musa SP) there are two different values where the value of TDS 625 mg/L and TSS 475 mg/L. Based on the Kementrian Lingkungan Hidup (15) concerning Water Pollution Control Procedures, the results obtained are categorized as high, this is because the intermediate limit of TDS in domestic wastewater under the regulation is 500 mg/L. Meanwhile, the results obtained from the TSS Test are 475 mg/L, based on Kementrian Lingkungan Hidup (15) No. 01 of 2010 concerning Water Pollution Control Procedures, this result has exceeded the threshold because the highest standard for TSS quality in domestic wastewater is 350 mg/L.

Figure 1: The comparison of TDS number by using water hyacinth and banana stem on wastewater for 4 weeks

In the results of treatment using water hyacinth for 2 weeks, the results obtained TDS values increased to 655 mg/L compared to before treatment but it dropped dramatically on the 3rd week and 21 ie 485 mg/L and 311 mg/L. TDS value increase on 2nd week with treatment using water hyacinth because on the 2nd week the water hyacinth plants do the absorption process through the roots, this is because the process of photosynthesis allows the release of oxygen by water hyacinth increasing TDS. While the value of TDS on 3rd week decreased to 485 mg/L, the decrease TDS value on the 3rd week is due to water hyacinth being able to grow well so water hyacinth can reduce levels of water pollutants. aquatic plants such as water hyacinth can be developed as a cleaning pollutant levels in liquid waste where water hyacinth can absorb various water pollutants, including Lead, cadmium, which may be dissolved in water so that water hyacinth can reduce TDS levels (16).

The TDS value 4th week was further decreased by 311 mg/L. According to Magar, Khan (17) his is due the roots of Water hyacinths naturally absorb pollutants including lead, mercury, and some organic compounds which are carcinogenic and have concentrations of approximately 10,000 times that is present as in generically found water because water hyacinth can adapt well until the
4th week on wastewater so that this makes the reduction in TDS values more significant. This is in line with research conducted by Moyo, Chapungu (18) stated that water hyacinth was remediating the river as noted by the significant reduction of electrical conductivity (25% decrease), total dissolved solids (26%), sulfates (45%), phosphates (33%) and total hardness (37%) between the sample points SR1 and SR3.

According to Kementrian Lingkungan Hidup (15) concerning Water Pollution Control Procedures and TDS quality standards allowed for domestic wastewater, the TDS value 4th week has been in the low category on the results of the treatment using banana stems, the TDS value on the 2nd week after treatment was reduced to 563 mg/L, on the 3rd week it also decreased to 525 mg/L but increased dramatically on the 4th week to 775 mg/L. The decrease in TDS 2nd week is due to the fact that the biofiltration method using banana stems is useful to inhibit the growth of some pathogenic bacteria and filter out solid material in the waste so that the biofiltration method can reduce levels of solid pollutants. Decreasing levels of pollutants after the process biofiltration occurs significantly day 6 to 97.23% compared with control(19).

Decreased TDS on the 3rd week because banana stems have carbon content and this content serves to filter dissolved particles through biofiltration method so that the banana stems can reduce TDS. Meanwhile, on the 3rd week the TDS increases dramatically because the banana stems have organic properties if left exposed to water for more than 2 weeks, the banana stems will rot and affect the biofiltration process so the results obtained are not homogeneous. This happens because the banana stems occur eutrophication process so that this decay affects the value of TDS and TSS(20).

According to Kementrian Lingkungan Hidup (15) concerning water pollution control procedures and TDS quality standards allowed for domestic wastewater, the TDS value on the 4th week has been in the medium category.

The value of the TSS in treatment using water hyacinth for 2 weeks decreased to 417 mg/L compared to before treatment, but on the 3rd week TSS increased to 450 mg/L and suddenly decreased dramatically on the 4th week to 417 mg/L. The decreasing value of TSS on the 2nd week is because water hyacinth can clarify liquid waste and reduce solid particles contained in wastewater. These results are following research conducted by Ruhmawati, Sukandar (21) stated that the reduction in TSS levels, the average percentage decrease in TSS levels for contact time 2 days 47.43%, for contact time 4 days 74.85%, and for contact time 6 days by 80.63%. the decrease in TSS is due to the function of water hyacinth weeds in purifying liquid waste and absorbing solid

![Figure 2: The comparison of TSS number by using water hyacinth and banana stem on wastewater for 4 weeks](image-url)
particles so that it will create good conditions for the phytoremediation process.

The decreasing value of TSS by using water hyacinth on 4\textsuperscript{th} week because phytoremediation by using water hyacinth is able to absorb solid particles contained in wastewater. Phytoremediation processes rely on the ability of plants to take up and/or metabolize pollutants to less toxic substances. The uptake, accumulation, and degradation of contaminants vary from plant to plant. The plants used in phytoremediation are generally selected on the basis of their growth rate and biomass, their ability to tolerate and accumulate contaminants, the depth of their root zone, and their potential to transpire groundwater. The plants used in phytoremediation should not only accumulate, degrade or volatilize the contaminants but should also grow quickly in a wide range of different conditions\textsuperscript{(13)}. The technology of Phytoremediation offers a viable solution to water pollution\textsuperscript{(22)}.

According to Kementrian Lingkungan Hidup \textsuperscript{(15)} No. 01 of 2010 concerning Water Pollution Control Procedures and TSS quality standards allowed for domestic wastewater, the TSS value on the 4\textsuperscript{th} week still in the high category. This shows that although the TSS value has decreased, it still takes a long time to comply with the standards set by the environment ministry. Meanwhile, the TSS results obtained of the treatment using banana stems 2\textsuperscript{nd} week after treatment reduced to 418 mg/L compared to before treatment and on 3\textsuperscript{rd} week increased to 480 mg/L, but decreased dramatically on day 4\textsuperscript{th} week to 417 mg/L. The decreasing value of TSS on 2\textsuperscript{nd} week because biofiltration by using banana stems is able to filter out solid particles contained in wastewater. There is a high possibility for the effective application of biofilters for the removal of toxic heavy metals from contaminated water on a large scale. In short, the biofilters are having emerging applications for the treatment of heavy metals contaminated wastewater. It is very important to note that a good system to biofiltration provides the best condition for the microorganisms and, consequently, will achieve a high efficiency\textsuperscript{(14)}.

The increasing value of TSS on 4\textsuperscript{th} week because of the composition of banana stems that have organic properties so that bacteria will easily develop and make banana stems rot. Banana stems that are too long exposed to water can interfere with the biofiltration process due to natural decay. This happens because the banana stems occur eutrophication process so that this decay affects the value of TDS and TSS\textsuperscript{(20)}.

Conclusions

Phytoremediation by using water hyacinth is more effective in reducing levels of TDS and TSS in domestic wastewater than biofiltration by using banana stems.

Conflict of Interest: The authors declare there is no conflict of interest.

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Ethical Clearance: No Relevant. This research did not involve humans as subjects.

References


