Studies on decreasing Chemical Oxygen Demand (COD) and Phosphate on laundry wastewater using anaerobic and phytoremediation with algae plants (*Hydrilla verticillata*)

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Abstract. In reducing the pollutant load contained in laundry wastewater such as COD and phosphate levels can be processed through anaerobic process and will be followed by phytoremediation methods. The purpose of this study is to reduce levels of COD and phosphate in laundry wastewater. This research was conducted in a laboratory scale with variations in plant mass. One type of aquatic plants that has the potential in phytoremediation waste management is algae (*Hydrilla verticillata*). The initial step in this research was carried out the seeding stage in anaerobic reactors with the aim of breeding bacteria with a suspended culture method which was marked by a decrease in COD with ±10% fluctuations. Followed by the running stage in the anaerobic reactor until the reduction in COD ≥60% then, the stage of neutralization and acclimatization of plants with the aim of removing impurities in plants and adaptation of plants with microorganisms in wastewater. The last stage is the running stage of the phytoremediation process which is carried out by observing the value of COD and Phosphate in wastewater with variations in plant mass of 50, 100, 150, 200 and 250 grams in each reactor with contact time treatment for 7 days. Based on the analysis of COD parameters for each plant after anaerobic and phytoremediation processes on the last day the average efficiency of COD removal at 50 grams of plant mass is 86.34%, 100 gram plant mass of 81.81%, plant mass of 150 grams of 85.21%, 200 gram plant mass of 90.87% and 250 gram plant mass of 87.47% while the results of the analysis of Phosphate COD parameters for each plant the average removal efficiency of Phosphate in 50 gram plant mass is -25 %, 100 gram plant mass of -298.81%, 150 gram plant mass of -417.86%, 200 gram plant mass of -501.19% and 250 gram plant mass of -462.5%.

1. Introduction

Laundry services are increasing population growth rates each year. This service is useful for the user community and service providers. Increasing of laundry service activities require that service providers manage the waste produced to prevent environmental pollution [2].
In reducing the pollutant load contained in laundry wastewater is processed through anaerobic process and then followed by phytoremediation methods [28]. Anaerobic wastewater treatment aims to break down organic matter present in wastewater into simpler, non-hazardous materials [30]. Indonesia is blessed with various types of flora, these various types of flora are estimated to have potential as hyperaccumulators or plants that have the potential to remediate naturally polluted environments [13].

A system where plants either alone or with the help of microorganisms can change pollutants that were originally harmful to the environment into harmless or less dangerous to the environment can be done with a phytoremediation system [24]. The advantage of this phytoremediation method is that it does not require complicated equipment and expertise, and is more environmentally friendly. Besides that it is effective for treatment with large volumes of wastewater or those with low concentrations [24].

Alternative management of laundry wastewater that is cheap, easy and affordable, i.e. with phytoremediation treatment techniques using plants to absorb pollutant loads such as phosphates and others. One type of aquatic plants that has the potential in waste management is algae (Hydrillaverticillata) [4].

The research that will be conducted is to reduce levels of Chemical Oxygen Demand (COD), and Phosphate using algae plants (Hydrillaverticillata) anaerobically and phytoremediation. Analysis of COD and Phosphate reduction in samples using the Complete Random Design method.

2. Research methodology

2.1 Research object
In this study the object to be investigated is the efficiency of decreasing levels of Chemical Oxygen Demand (COD) and Phosphate in anaerobic laundry wastewater treatment and phytoremediation by Hydrillaverticillata plants.

2.2 Research design
This research will use a batch system with the following characteristics:
In this study, the container used was 1 reservoir reservoir with a capacity of 150 liters, 1 container made of glass with a size (30 x 30 x 50) cm with a capacity of 45 liters in the anaerobic process and 4 plastic containers with a capacity of 5 L, where 5 containers for Hydrillaverticillata plants with weight variations of 50, 100, 150, 200 and 250 grams with a volume of waste water 5 liters, and 1 container for control water.

2.3 Seeding process in anaerobic reactor
Laundry wastewater filtering is carried out to separate the waste that is collected at the time of sampling. Laundry wastewater is put into an anaerobic reactor with a volume of 45 liters. Seeding process is carried out in batch. The outer surface of the anaerobic reactor is covered using carbon paper. The seeding process is carried out for 21 days based on [23] research about laundry wastewater treatment using anaerobic-aerobic biofilter with bioball media with seeding time for 21 days, This proves that the growth of microorganisms occurs. During the seeding process, pH and VSS (Volatile Suspended Solid) test were carried out to determine the biomass in the reactor, as well as a COD test to determine the substrate concentration in the reactor and the addition of sugar as nutrients to bacteria.

2.4 Running process in anaerobic reactor
After the seeding process in the anaerobic reactor is stable, running process is carried out. Laundry wastewater sampling and analysis were carried out before flowing to the reactor to get the COD values and Phosphate values at the inlet. Laundry wastewater that is accommodated in the reservoir will then be
streamed in batch. The experiment was carried out with a residence time of ±7 days (reduction in COD levels reached 60%). Sampling is carried out at the reactor outlet. Perform COD and phosphate testing.

2.5 Acclimatization on algae plants (Hydrilla verticillata)
Plants are cleaned with running water from dirt that sticks to the roots. The plants were put in a phytoremediation reactor and soaked in clean water for one week, before being replaced with laundry wastewater, a one-week selection based on research by [26]. Clean water is replaced with wastewater by flowing gradually until the water is replaced with 100% wastewater. Substitution of water is done for 6 days. The stages of the process of acclimation of algae (Hydrilla verticillata) can be seen in table 1.

Table 1. Acclimatization stage on algae plants (Hydrilla verticillata)

| Acclimatization stage | Clean water (%) | Laundry wastewater (%) |
|-----------------------|-----------------|------------------------|
| Stage 1               | 90              | 10                     |
| Stage 2               | 80              | 20                     |
| Stage 3               | 60              | 40                     |
| Stage 4               | 40              | 60                     |
| Stage 5               | 20              | 80                     |
| Stage 6               | 0               | 100                    |

2.6 Running process on Hydrilla verticillata plants
COD and Phosphate tests were carried out on the anaerobic reactor which would previously be processed before being flowed at the phytoremediation reactor. The running process will be carried out after the acclimatization process runs well. Running process is done in a batch system. The running process is carried out with variations in contact time on days 0, 1, 2, 3, 4, 5, 6 and 7 as well as variations in plant weight of 50, 100, 150, 200 and 250 grams. COD and Phosphate measurements were taken at the phytoremediation reactor outlet.

3. Results and discussion

3.1 Wastewater characteristics
The waste used in this research is laundry waste water taken from the outlet. As for the reason for the use of this waste due to the use of bacteria from the outlet pipeline and it is expected that wastewater taken from one point can represent other laundry wastewater. The quality of laundry wastewater used in the study can be seen in table 2.

Table 2. Laundry wastewater characteristics

| Parameter       | Unit | Concentration | Quality standards | Information          |
|-----------------|------|---------------|-------------------|----------------------|
| COD             | mg/l | 540,6         | 100**             | Exceeded             |
| Phosphate       | mg/l | 3,36          | -                 | Not set              |
| pH              | -    | 9,1           | 6-9**             | Exceeded             |
| Surfactant      | mg/l | 16,4880       | 5-10**            | Exceeded             |
| TSS             | mg/l | 196           | 30*               | Exceeded             |

* PeraturanMenteriLingkunganHidupdanKehutanan No. 68 Tahun 2016
** PeraturanMenteriLingkunganHidup No. 5 Tahun 2014 (Golongan I)
Based on the table above, it can be seen that the laundry wastewater used in this study has a concentration of all parameters that entirely exceed the quality standards specified in [20] concerning Wastewater quality standards for businesses and / or activities that do not yet have Wastewater Quality Standards and [21] concerning Domestic Wastewater Quality Standards. Phosphate parameters do not have a quality standard outlined in national regulations, then COD became the parameter tested.

3.2 Seeding results

Based on visual observations, it can be seen that on the surface of wastewater a white biofilm layer is formed and there are a few black biofilm layers which are getting thicker from day to day starting on the 2nd day of the seeding stage. Based on [11] research, if in the wastewater there is a brownish black mucus layer, it can be concluded that microorganisms begin to grow and when organic compounds begin to break down, the color of wastewater usually turns dark.

PH and temperature conditions are factors that influence the breeding of microorganisms. From the results of the pH analysis conducted during the seeding process, the pH value continues to decrease. In this study, the results of pH measurements under anaerobic conditions showed a value of 4.7 - 9. On the 9th day and 11th day the pH value decreased significantly, this occurs because the organic matter in the wastewater decomposed at the acidogenesis and acetogenesis stages which is characterized by the formation of volatile acids which will reduce the pH value in the reactor [14]. According to [27] microorganisms have a growth range at pH 4 - 9.5 with an optimum pH of 6.5 - 7.5. In anaerobic conditions can form H2S gas and if the concentration of dissolved oxygen in it is large enough then the H2S gas that is formed will be converted to sulfate (SO\(_4\)) by sulfate bacteria contained in biofilms and suspended, this will affect the decrease in pH in anaerobic conditions. According to [6], the optimum pH for the growth of bacterial remodeling and producing organic acids is acidic pH. The results of temperature measurements in this study indicate a value of 28-29 ℃. According to [33] bacteria can multiply optimally at a temperature of 25 - 35 ℃. Then, the pH and temperature obtained meet the bacterial growth requirements in the reactor. The graph of the pH value in the seeding process can be seen in Figure 1.

**Figure 1.** Results of pH on anaerobic seeding analysis
Based on the results of COD analysis in anaerobic reactors, the initial COD value when doing seeding obtained a value of 393.72 mg/l. During the seeding process, microorganisms contained in wastewater are not fed until the dissolved COD value drops. In this study VSS test was also carried out to determine the occurrence of bacterial activity in the processing process. In this study the initial value of VSS was obtained during the seeding process at 510.34 mg/l and at the final stage of the seeding process the value of VSS was obtained at 84.13 mg/l. According to [12], if the dissolved COD parameter decreases, indicating that there is already bacterial activity. This bacterial activity is indicated by a decrease in the value of VSS which means that methane gas has begun to be produced.

Starting on day 0 to day 1 there was a significant decrease in COD concentration from 393.72 mg/l to 144.84 mg/l, COD concentration continued to decrease until the 9th day with a COD concentration of 75.48 mg/l. Then there was a decrease but not significantly on the 21st day with a concentration of 77.52 mg/l with an allowance of 80%. The best removal time at the seeding stage in the anaerobic reactor is on the 9th day. On the 9th day, the COD fulfilled the requirements to be continued with the running stage in the anaerobic process. According to [6] an increase in the value of COD indicates that the hydrolysis process in the anaerobic treatment process has occurred in the reactor. On the 11th day and the 14th day the increase in COD value indicates that the bacterial cell has begun to adapt to the given substrate and the environmental conditions in the reactor (lag phase). Based on [32] research, the seeding process can be considered steady or said to be successful if there is a decrease in the value of COD with fluctuations <10% and visual observations with a COD value of 77.52 mg/l and a VSS value of 84.13 mg/l.

According to [22] the stable removal of COD shows that microorganisms are able to adapt to the environment well and indicate that the conditions in the reactor are steady and ready to set aside the parameters of pollutants in the wastewater to be treated. Thus the seeding process can be stopped and ready to proceed to the running stage. The following graph shows the value of COD in the seeding process can be seen in Figure 2.

![Figure 2. Results of COD on anaerobic seeding analysis](image)

3.3 Acclimatization results

Based on research it can be seen that the value of COD is increasingly decreasing this indicates the activity of microorganisms that grow and degrade organic compounds contained in the wastewater. Based
on the research of [30] the efficiency of COD removal in the Anaerobic Fixed Bed Reactor process occurs at a flow of 60 ml / min with a COD concentration of 58.2 mg / l (20% waste) with a 91% allowance and if the discharge is increased then the percentage COD becomes smaller. This shows that the longer the residual wastewater time in the reactor, the removal efficiency also increases, because anaerobic bacteria with waste water become more and more contacted so that processing results are better. Based on [3] research, the process of degradation of organic compounds which results in a decrease in COD occurs in anaerobic reactors. It can be seen that the residence time affects the COD removal, the more the residence time, the longer the waste is contacted with the bacterial media so that the removal efficiency is higher as well. In this study the efficiency of COD removal in the 7th day anaerobic reactor showed a value of 59.65% or almost 60%. This has fulfilled the requirements to proceed to the next stage in accordance with the planned research method. The following graph shows the results of the COD analysis on the running process of the anaerobic reactor can be seen in Figure 3.

The parameters of the phosphate test carried out in the laboratory are the phosphate values in the form of orthophosphate. Based on the results of phosphate analysis conducted in the study an increase, it is known the initial value of orthophosphate contained in influent laundry wastewater is equal to 3.36 mg / l. On day 0 to day 2 of the running process in anaerobic reactor there is a significant increase in phosphate compounds, this right can occur because there are several types of bacteria in an anaerobic atmosphere that can release polyphosphates stored in bacterial cell biomass into wastewater [17]. On the 3rd day there was a significant decrease in phosphate concentration, this happened because in the wastewater there were PAO (Polyphosphate Accumulating Organism) bacteria, these bacteria are bacteria that have the ability to accumulate phosphorus to meet the needs of the formation of cell components and also accumulate polyphosphate compounds in its cells [15]. On the 4th day there was also an increase in phosphate concentrations, the increase in phosphate values that occurred in the reactor occurred due to the absorption of organic materials and in the anaerobic hydrolysis process of polyphosphates to form a simpler compound that is orthophosphate which will be released under anaerobic conditions. PAO (Polyphosphate Accumulating Organism) bacteria carry out hydrolysis of polyphosphates to obtain energy that can be used to take volatile fatty acids in wastewater which then release the results of hydrolysis of

![Figure 3. Results of COD on anaerobic running analysis](image-url)
polyphosphates [36]. According to [9] all polyphosphates will be hydrolyzed to form orthophosphate. On the 7th day the orthophosphate concentration increased after going through anaerobic reactor processing to 13.1 mg/l. The following graph shows the results of phosphate analysis in the running process of the anaerobic reactor can be seen in Figure 4.

![Figure 4. Results of phosphate on anaerobic running analysis](image)

COD and phosphate removal is certainly influenced by pH and temperature conditions. In this study the results of the pH measurement on the anaerobic reactor are 4.5 - 4.8 while the measurement result of the temperature on the anaerobic reactor is 27 - 30 °C. According to [29] phosphorus removal will decrease in the pH range between 7.5 - 8 and phosphorus removal will decrease if the pH is below 6.5 and all phosphorus removal activity will be lost if the pH approaches 5. Low temperature does not affect the removal of COD or phosphate. The following graph shows the results of the pH analysis on the running process in anaerobic reactor can be seen in Figure 5.
3.4 Neutralization and acclimatization on algae plants

The neutralization process in this study was carried out for 7 days in accordance with the research of [26] where the neutralization process of Hydrillaverticillata plants can be carried out by means of the plants put in a phytoremediation reactor and soaked in clean water for 7 days before being replaced with laundry wastewater. After 7 days the neutralization process is complete.

After the plant neutralization process is complete, it is followed by an acclimatization process. The acclimation process is the adaptation of plants and microorganisms in the wastewater to be treated. The acclimation process is carried out in batches because it is expected that microorganisms can adapt and develop to new conditions slowly [34]. In the acclimatization process, 6 stages are carried out in replacing wastewater into the reactor, where in each stage the pH and temperature tests are carried out. In the acclimatization process, the pH values were in the range of 5.8 - 7.6 and the temperature in the range 26 - 28 °C. According to [8], Hydrillaverticillata can live in a range of pH ranging from acidic to neutral pH so that the pH conditions in the study are considered to have met. According to [35], photosynthetic activity in plants will not run well if the water temperature is below 5 °C or above 50 °C so that the water temperature conditions in the acclimatization process can be considered fulfilling. The following graph results of the analysis of pH in the process of plant acclimation can be seen in Figure 7.

![Figure 5. Results of pH on anaerobic running analysis](image-url)
Running results on phytoremediation of plants

The temperature obtained in this study was obtained from 26.6 - 28.8 °C, where on the 0th day running until the 4th day the temperature value obtained was still at 27°C while on the 5th and 6th days the temperature began increased until it reached a value of 28.8 °C. Temperature change is an environmental factor that can play a role in the growth process that affects enzymes in the photosynthesis process. The higher the temperature value, the oxygen levels will decrease [5].

The pH value obtained in this study is 5.2 - 7.6. During the running stage in the phytoremediation process the pH of the wastewater increases but on the 3rd and 5th days the pH of the wastewater decreases. According to [19], the increase in pH during observation occurred due to increased running time of phytoremediation treatment. The pH value of water can determine the presence of elements that are toxic to organisms and nutrient ions that are absorbed. According to [25], a high or increased pH is caused by photosynthesis which produces O₂ and releases H- ions and takes H⁺ ions contained in water. On the 7th day the temperature in the wastewater drops to 26°C, this can occur because the H⁺ ions caused by decaying plants that fall out have a physical impact on the plant by damaging the root root system so that it inhibits the rizhofiltration process. The following graph shows the results of phytoremediation pH running can be seen in Figure 8.

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**Figure 6.** Results of pH on acclimatization’s plants

![Graph showing pH changes over different operation times and loadings]

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3.5 Running results on phytoremediation of plants
3.5.1 Effect of Variations in Plant Mass on COD Allowance. Based on the analysis of COD parameters for each plant mass, it can be seen that during the contact time for 7 days at 50 grams of plant mass the average efficiency of COD removal was 61.46%, 100 gram plant mass of 67.91%, plant mass 150 grams of 69.49%, 200 grams of plant mass of 71.36% and 250 grams of plant mass of 70.08%. COD value in the phytoremediation process has decreased, but on the 5th day and 6th day has increased. One thing that causes an increase in COD value is due to media factors, at the beginning of the study that worked optimally in reducing pollution in wastewater is the media and microorganisms until a certain time the media enters the saturation phase and which effectively works in reducing contamination levels only microorganisms so that at 7th day there was a decrease in the value of COD again because of the activity of microorganisms in reducing pollution [16] Another thing that causes an increase in COD value in this process is because the Hydrillaverticillata plant dies and decays. The decay process is characterized by the release of plant leaves from the stem so that it affects the physical changes in water in the reactor. Based on the research of [31], the time of the study conducted on the 8th day and the 10th day there was an increase in the concentration of BOD and COD in plants Lemna minor and Hydrillaverticillata due to the saturation of wastewater due to decay from roots, stems and leaves from plants that are no longer able to compete get nutrients with a reduced volume of wastewater.

Based on the results obtained in this study, it can be concluded that the Hydrillaverticillata plant can eliminate COD to below the quality standard based on [21] and [20] despite an increase in COD concentrations on days 5 and 6 of the process of running phytoremediation. In addition, it can be seen in this study that Hydrillaverticillata has a higher ability in removing COD in plant mass of 200 grams / 5 liters of water. The following graph shows the results of the COD running phytoremediation can be seen in Figure 9.

Figure 7. Results of pH on phytoremediation running process

![Graph showing pH results over operation time for different plant masses, including 50 gram, 100 gram, 150 gram, 200 gram, and 250 gram. The graph illustrates the pH values over a 7-day operation period.]
3.5.2 Effect of Variations in Plant Mass on Phosphate Allowance. Based on the analysis of phosphate parameters for each plant mass, it can be seen that during the 7-day residence time the average removal efficiency of phosphate in 50 gram plant mass is 66.32%, 100 gram plant mass is 27.96%, plant mass 150 grams of -87.88%, plant mass of 200 grams of -7.25% and plant mass of 250 grams of -82.63%. This is inversely proportional to the research of Basiru et al (2015) on the effectiveness of algae plants (Hydrillaverticillata) in reducing phosphate levels ($PO_4^{3-}$) in laundry waste X which states that there are variations in the weight of algae plants (Hydrillaverticillata) in reducing phosphate levels turned out to be influential. The study was conducted with variations in plant weight, namely 150 grams, 200 grams and 250 grams for 15 days. On the 15th day the weight variation of algae (Hydrillaverticillata) 250 grams had a high phosphate decrease of 1.35 mg/l while in the phytoremediation reactor the Hydrillaverticillata plant mass of 250 grams showed the lowest phosphate removal efficiency compared to other plant mass variations, effluent phosphate is higher than influent phosphate concentration. It can be seen that in this study Hydrillaverticillata has the ability to eliminate a larger phosphate that is the plant mass of 50 grams / 5 liters of water.

The decay on the stems or leaves of plants that have died then completely submerged in wastewater causes organic phosphate to decompose again so that phosphate levels increase again (Koesputri et al, 2016). In nature, phosphorus compounds are divided into two forms, namely organic phosphate compounds and inorganic phosphate compounds, where organic phosphate compounds are found in plants and animals while inorganic phosphate compounds are present in water and soil [18]. Organic phosphate can come from bacteria or plants that absorb phosphate [15]. The following graph shows the results of phosphate analysis of the phytoremediation running process can be seen in Figure 10.
3.6 Surfactant allowance and Total Suspended Solid (TSS)

Based on variations in plant mass carried out in the phytoremediation process, the most effective plant in reducing COD parameters is 200 gram plant mass while phosphate reduction is 50 gram plant mass. Based on the analysis results obtained COD removal in 50 gram plant mass is below the quality standard, so that 50 gram plant mass is effective in COD and phosphate removal so that surfactant and TSS testing is carried out on the effluent phytoremediation reactor of 50 gram plant mass. Test results on surfactant and TSS parameters are known to have decreased concentrations in the final stages of wastewater treatment. The reduction efficiency of surfactants reached 97%, with initial surfactant concentrations of 16.48 mg/l to 0.49 mg/l. Based on [28] research, decreasing the concentration of MBAS (Methylen Blue Active Substance) or surfactant reaches 87.16% after going through the stages of anaerobic-aerobic process and phytoremediation using Salvinia molesta plants, the effectiveness of decreasing MBAS levels when the anaerobic system is obtained with a value of 60.96%, on the effectiveness of the aerobic system MBAS reduction by 22.6% while in the 5-day phytoremediation 14.34% allowance was obtained on the 10-day phytoremediation 25.67% and on the 15-day phytoremediation a 33.32% allowance was obtained. From these data it can be seen that a greater decrease in surfactant concentration occurs in the anaerobic process and is more effective if it is continued with the phytoremediation process.

The efficiency of TSS reduction reached 91% with an initial TSS concentration of 196 mg/l to 16.9 mg/l. Based on Safitri's research (2019) about the use of Lemna minor and Hydrilla verticillata to improve the quality of laundry wastewater, after 14 days treatment of TSS reduction was obtained with a percentage of 47.67% - 52.87%. It is suspected that Hydrilla verticillata plants absorb TSS more when compared to Lemna minor. Based on [10] research, Lemna minor and Hydrilla verticillata in remediating domestic wastewater for 20 days decreased TSS concentrations by 72.44%. The decrease in TSS is influenced by the length of time the plants contact with wastewater. The results of surfactant and TSS analysis can be seen in table 3.
Table 3. Results of concentration Surfactant and TSS

| Parameter | Unit | Initial concentration | Final concentration | Removal percentage (%) |
|-----------|------|-----------------------|---------------------|------------------------|
| Surfactant | mg/l | 16,4880               | 0,4913              | 97                     |
| TSS       | mg/l | 196                   | 16,9                | 91                     |

3.7 Comparison of Early and Late Hydrillaverticillata Plants

In this study it can be seen that the variation in plant mass of 50 grams has been effective in reducing the concentration of COD and Phosphate in laundry wastewater with an initial concentration of COD 464.92 mg / l to 73.85 mg / l while the initial concentration of phosphate was 5.6 mg / l to 4.2 mg / l. The effectiveness of Hydrillaverticillata plant mass variations is also characterized by changes in plant mass beginning and end of the phytoremediation process. During the process of running at the phytoremediation stage Hydrillaverticillata plants experienced a very significant weight loss, this shows that Hydrillaverticillata plants do not turn organic material contained in laundry wastes into nutrients but only as adsorbents or as absorbers of organic loads in wastewater and death has occurred. and decay in plants causing a decrease in plant mass in the final stages of the phytoremediation process. Death and decay that occurs in plants caused by Hydrillaverticillata plants experiencing saturation in accumulating organic loads in waste water [35]. Another thing that causes the process of death and decay in Hydrillaverticillata plants due to plants directly exposed to the sun with a lot of intensity, so it tends to die faster and rot [31]. The highest percentage of decrease in plant mass is 200 gram plant mass while the smallest percentage of plant mass reduction is 50 gram plant mass. The results of the analysis of changes in plant mass Hydrillaverticillata can be seen in table 4.

Table 4. The results of the analysis of changes in plant mass hydrillaverticillata

| Hydrolla verticillata | Initial mass (gram) | Final mass (gram) | Percentage decrease in plant mass (%) |
|-----------------------|---------------------|-------------------|---------------------------------------|
| Plants 1              | 50                  | 47,87             | 4,26                                  |
| Plants 2              | 100                 | 88,54             | 11,46                                 |
| Plants 3              | 150                 | 76,42             | 49,05                                 |
| Plants 4              | 200                 | 91,52             | 54,24                                 |
| Plants 5              | 250                 | 132,81            | 46,87                                 |

4. Conclusions

Contact time affects the removal of organic matter contained in wastewater. In the anaerobic process, the longer the contact time the organic load allowance increases. The best contact time in the phytoremediation process is on the 4th day, this is due to the absorption of organic matter and phosphate on the 4th day is below the quality standard compared to the 5th and 6th days. On days 5 and 6 there was an increase in COD and Phosphate because Hydrillaverticillata plants had begun to die and rot.

In anaerobic reactors COD decreased with a removal efficiency of 59.65%. In the anaerobic process a phosphate test is carried out in the form of an orthophosphate compound while at this stage the hydrolysis process of the polyphosphate compound becomes a simpler compound, orthophosphate so that the phosphate parameter increases by 74.35%. In the phytoremediation process the best COD removal efficiency occurs in 200 gram plant mass variations of 77.37% while the best phosphate removal efficiency is in the 50 gram plant mass variation of 67.94% Surfactant and TSS removal efficiency in anaerobic and phytoremediation processes by 97% and 91%.
In this research, there is a correlation between the influence of plant mass variation on the phytoremediation process to COD and Phosphate removal. The most effective plant mass removal of COD was at 200 gram plant mass, where the COD value decreased from anaerobic reactor effluent 510.0 mg/l to 73.85 mg/l while the most effective plant mass in the removal of Phosphate parameters was the mass variation 50 gram plants which decreased phosphate from anaerobic reactor effluent 13.1 mg/l to 4.2 mg/l.

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