Post utilization of *eceng gondok* and *ketapang* leaf extract to reduce phosphate levels in domestic waste

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Abstract. Utilization of enceng gondok (*Eichornia crassipes*) and ketapang (*Terminalia catappa*) was to reduce phosphate levels in domestic waste. This study aims to determine the effectiveness of the combination of *E. crassipes* and *T. catappa* leaf extract in reducing phosphate levels in household wastewater and determine the optimal time that can be generated of the use of a combination of *E. crassipes* and *T. catappa* leaf extract. The approach of this research is an experimental study that aims to treat domestic phosphate-containing wastewater, using small-scale wastewater installations with a simple process for the treatment of waste produced from households. The results of this study showed that the combination of *E. crassipes* and *T. catappa* leaf extract effectively had a significant effect in reducing the value of phosphate content in the wastewater. While the optimal residence time in this study was obtained, a decrease in phosphate levels using a combination of *E. crassipes* and *T. catappa* leaf extract occurred on the 18th day.

1. Introduction

It is well known that the use of clean water can consist of washing clothes, rinsing baths, transporting vehicles such as motorcycles and cars, to using clean water for the transportation of human waste [1]. Required wastewater that comes from household products, directly sent to the full body of the Environment, without any prior. Wastewater that is discharged directly into the environment without further processing can cause environmental pollution [2]. In general, almost all people have used detergent, for the purposes of cleaning dirty clothes, cleaning furniture or kitchen utensils and others including its use by small industrial needs such as laundry in residential areas, which is one of the very intimate activities in direct contact with detergents which is one of the most widely used commercial products to remove impurities in the process of washing clothes and others [3]. Wastewater comes from the community and households and also from industry, groundwater, surface water, and other wastes. Thus this wastewater is a matter of general impurities [4].

Detergents are very difficult to decompose because they contain active compounds of surfactants that are difficult to degrade and are certainly very dangerous for health and the environment. Most detergents contain sodium tripolyphosphate (STP), which is one of the ingredients in detergents. Its function is as a builder, which is the second element after surfactant because of its ability to remove...
hardness minerals in water so that detergents can work optimally. The combination of STP with surfactants in detergents can enhance the phosphate content in water. Excess phosphate in the body of water will cause eutrophication, where plants such as algae grow very fast compared to growth in general, so it is necessary to use alternatives to plants to reduce the possibility of eutrophication, one of the ways that can be used is by using the phytoremediation method [5].

Phytoremediation is the effort to use plants and their parts for decontamination of waste and environmental pollution problems both ex-situ (directly in the field) and on land or areas contaminated with waste [6,7]. One method that uses plants is to use E. crassipes and T. catappa. E. crassipes is a floating aquatic plant with thick leaves and bubbles, whereas T. catappa is a type of plant that is generally planted with functions as a protection tree in the coastal area as a shade tree [8].

E. crassipes plants are used in this study because these plants are often known as weeds in waterways because of their rapid growth, in addition to rapid growth. It can also cause a decrease the solubility of oxygen in water, the amount of light entering the waters, the production value in the fisheries sector, in the aesthetic value of the environment, and accelerate the process of silting caused by dead E. crassipes plants. Aside from its negative side, E. crassipes also have a positive aspect of the environment, which can absorb heavy metal pollutants, which are pollutants for the environment [9]. From several studies conducted previously, that at the beginning of the study, conducted E. crassipes plants could reduce levels of phosphate as total phosphate in small industrial wastewater laundry (laundry) [10]. As for other studies, concluded that the effectiveness of the number of E. crassipes clumps in controlling domestic wastewater is very useful.

Based on this, this study aims to determine the effectiveness of the combination of E. crassipes and T. cattapa leaf extract in reducing levels of phosphate in household wastewater and determine the optimal time that can be generated from the use of a combination of E. crassipes and T. cattapa leaf extract.

2. Materials and Method

2.1. Research method and location

The location of this research was carried out on Moncongloe Lappara Street, Manggala, Abdullah Daeng Sirua Street and Jalan Raya Raya No. 4, Borong, Manggala, Makassar City, South Sulawesi.

2.2. Research design

The research design used is an experimental study that aims to treat domestic wastewater containing phosphate, using a small-scale wastewater installation with a simple process to treat sewage generated from households.

2.3. Method

The reactor bath used is in the form of containers made of 9 plastic jerry cans, which were previously placed in a place that has sufficient light intensity, then the reactor bath preparation is done by filling the soil from the study site, after the soil was inserted, the next treatment is by entering domestic wastewater contained in the sewerage of residents' houses located in the study site into the reactor tub.

The preparation of aquatic plants used in this study was E. crassipes. The plant has been taken directly from the study site first, cleaned using clean water, weighed, and then placed on jerry cans. The portion of the T. catappa tree used in this study is in the form of T. catappa leaves that have been in the soil under dry conditions. T. catappa leaves collected cleaned from dirt that sticks to the leaves, such as soil and other impurities, then dried for 1-2 days.

Wastewater samples were taken and placed in a container with water collection ranging from ± 20 liters or until it is deemed sufficient to then be continued at the research stage. Wastewater sampling will not be carried out if it was rain. After the holding tub was ready, the first step that will be taken
was to insert the wastewater and canal water samples into the container that has been prepared and then put the *E. crassipes*. Wastewater that has been put into a tub containing *E. crassipes* was allowed to stand for 10 days, with the aim that the wastewater and materials that have been put into contact with these materials. Then after the wastewater was treated with *E. crassipes*, the wastewater was treated with *T. catapa* leaves. The use of *T. catapa* leaves was performed for 3 days to allow the wastewater and *T. catapa* leaves to be contacted.

### 2.4. Analysis of Data

The measurement of phosphate content in the domestic wastewater and canal water without treatment with *E. crassipes* and *T. catapa* leaves was first conducted. After that, the processing efficiency value of each treatment was calculated. The equation used to calculate the value of processing efficiency is given in equation (1)

\[ E = \frac{C_0 - C_i}{C_0} \times 100\% \]

where:
- \( E \) = the percentage of change
- \( C_0 \) = value before treatment
- \( C_i \) = value after treatment

To determine the ability of the treatment carried out in reducing pollutants contained in domestic wastewater, the content of phosphate in domestic wastewater and canal water was firstly measured without treatment using *E. crassipes* and *T. catapa* leaf extract. Furthermore, the measurement of phosphate content was conducted based on SNI 06-6989.31-2005.

### 3. Results

#### 3.1. The Effectiveness of the combination of *E. crassipes* and *T. catapa* leaf extract in reducing phosphate levels in household wastewater

Samples were taken at several monitoring points to find out the effectiveness of the combination of *E. crassipes* and *T. catapa* leaf extract. The first monitoring location was at a point at 4th Puri Raya street, Borong, Manggala District, Makassar City. The second monitoring location was at the point of the Nipa-Nipa canal located in Manggala Village, Manggala District, Makassar City. The third monitoring location was at the canal located in Abdullah Daeng Sirua street, Tello Baru Village, Panakkukang District, Makassar City.

Measurement of the phosphat content before and after treatment was conducted to find out the level of effectiveness of phosphate reduction by using *E. crassipes* and a combination of *E. crassipes* and *T. catapa* leaf extract. Laboratory test results obtained from a combination of *E. crassipes* and *T. catapa* leaf extract at the 4th Puri Raya street, Borong, Manggala District of Makassar City are presented in table 1. Laboratory Test Results of the Combination of *E. crassipes* and *T. catapa* extract in the Nipa-Nipa Canal, Manggala District of Makassar City, as given in table 2. Laboratory Test Results of a combination of *E. crassipes* and *T. catapa* extract at the location of Abdullah Dg. Sirua, Panakkukang District of Makassar City, is presented in table 3.
Table 1. Laboratory test results of a combination of water hyacinth and ketapang extract at a road location Jalan Puri Raya No. 4, Borong, Kecamatan Manggala, Makassar City.

| Treatment                                      | Dwell time | Result of phosphat PO₄ | Effectiveness (E) |
|------------------------------------------------|------------|-------------------------|-------------------|
| Wastewater                                     | 0          | 1.0453 mg/L             |                   |
| Domestic Wastewater + Eceng Gondok             | 3          | 1.0242 mg/L             | 0.0654 %          |
| Domestic Wastewater + Eceng Gondok             | 6          | 0.7935 mg/L             | 0.2861 %          |
| Domestic Wastewater + Eceng Gondok             | 9          | 0.1630 mg/L             | 0.8982 %          |
| Domestic Wastewater + Eceng Gondok + Ekstrak Daun Ketapang | 12  | 0.0953 mg/L             | 0.9541 %          |
| Domestic Wastewater + Eceng Gondok + Ekstrak Daun Ketapang | 15  | 0.1075 mg/L             | 0.9424 %          |
| Domestic Wastewater + Eceng Gondok + Ekstrak Daun Ketapang | 18  | 0.0298 mg/L             | 1.0167 %          |

Table 2. Laboratory test results of a combination of water hyacinth and ketapang extract at the location of the nipa-nipa canal, Kecamatan Manggala Makassar City.

| Treatment                                      | Dwell time | Result of phosphat PO₄ | Effectiveness (E) |
|------------------------------------------------|------------|-------------------------|-------------------|
| Wastewater                                     | 0          | 1.1194 mg/L             |                   |
| Domestic Wastewater + Eceng Gondok             | 3          | 0.9334 mg/L             | 0.2855 %          |
| Domestic Wastewater + Eceng Gondok             | 6          | 0.8753 mg/L             | 0.3374 %          |
| Domestic Wastewater + Eceng Gondok             | 9          | 0.5375 mg/L             | 0.6392 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 12  | 0.2258 mg/L             | 0.9176 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 15  | 0.1036 mg/L             | 1.1194 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 18  | 0.0284 mg/L             | 1.0940 %          |

Table 3. Laboratory test results of a combination of water hyacinth and ketapang extract on Abdullah Dg. Sirua canal, Kecamatan Panakkukang, Makassar City.

| Treatment                                      | Dwell time | Result of phosphat PO₄ | Effectiveness (E) |
|------------------------------------------------|------------|-------------------------|-------------------|
| Air Limbah                                     | 0          | 0.4688 mg/L             |                   |
| Domestic Wastewater + Eceng Gondok             | 3          | 0.34 mg/L               | 0.2564 %          |
| Domestic Wastewater + Eceng Gondok             | 6          | 0.1734 mg/L             | 0.0989 %          |
| Domestic Wastewater + Eceng Gondok             | 9          | 0.0465 mg/L             | 0.3696 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 12  | 0.0301 mg/L             | 0.4045 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 15  | 0.0257 mg/L             | 0.4139 %          |
| Domestic Wastewater + Eceng Gondok + Ketapang leaf extract | 18  | 0.0192 mg/L             | 0.4278 %          |
Laboratory Test Results of a combination of *E. crassipes* and *T. catappa* extract at the location of the 4th Puri Raya Street, Borong, Manggala District Makassar City, explains the phosphate content in wastewater before and after treatment. The content of phosphate in wastewater without treatment using *E. crassipes* on day 1 obtained a value of 1.0453 mg/L, domestic wastewater treatment using *E. crassipes* on days 3, 6 and 9 results obtained 1.0242, 0.7935, and 0.1630 mg/L, respectively while for wastewater treatment using *T. catappa* leaf extract on day 12 the results were 0.0953 mg/L, and on days 15 and 18 the results obtained were 0.1075 and 0.0298 mg/L, respectively.

Laboratory test results of the combination of *E. crassipes* and *T. catappa* extract at the Nipa Canal explained the content of phosphate in wastewater before and after treatment. The results of the phosphate content in canal water located in Nipa Canal without treatment using *E. crassipes* on day 1 obtained a value of 1.1194 mg/L. Domestic wastewater treated using *E. crassipes* on days 3, 6, and 9 results obtained 0.9334, 0.8753, and 0.5375 mg/L, respectively. For wastewater treatment using *T. catappa* leaf extract on day 12, the results were 0.2258 mg/L, and on days 15 and 18, the results obtained were 0.1036 and 0.0284 mg/L, respectively.

Laboratory Test Results of a combination of *E. crassipes* and *T. catappa* extract at the location of Abdullah Dg. Sirua, Panakkukang District Makassar City explained the percentage of phosphate content in wastewater before and after treatment. The results of the percentage of phosphate content in water canal located Abdullah Dg. Sirua located in Manggala sub-district without treatment using *E. crassipes* on day 1 obtained a value of 0.4688 mg/L, domestic wastewater treated using *E. crassipes* on days 3, 6 and 9 results obtained 0.34 mg/L, 0.1734 mg/L, and 0.0465 mg/L, respectively. For wastewater treatment using *T. catappa* leaf extract on day 12, the results were 0.0301 mg/L, and on days 15 and 18, the results obtained were 0.0257 mg/L and 0.0192 mg/L.

3.2. The optimum of time required to use a combination of *E. crassipes* and *T. catappa* extract

The optimal time to decrease phosphate levels by using *E. crassipes* and *T. catappa* leaf extract at Jalan Puri Raya Borong location shows that on the 9th day using *E. crassipes* can reduce phosphate levels. As for the use of *T. cattapa* leaf extract, the optimal time needed to be able to reduce phosphate levels occurs on the 18th day.

The optimal time to decrease phosphate levels by using *E. crassipes* and *T. cattapa* leaf extract location of the Nipa Canal shows that on the 9th day using *E. crassipes* can reduce phosphate levels. As for the use of *T. cattapa* leaf extract, the optimal time needed to be able to reduce phosphate levels occurs on the 12th day. When using the *T. cattapa* leaf extract, the phosphate content decreases also increases on the 15th day and again decreases until the 18th day.

The optimal time for phosphate levels to be reduced by using *E. crassipes* and *T. cattapa* leaf extract at the location of Abd Canal. Dg. Sirua shows that on the 9th day, using *E. crassipes* can reduce phosphate levels. As for the use of *T. cattapa* leaf extract, the optimal time needed to be able to reduce phosphate levels occurs on the 18th day.

4. Discussion

The optimal time for phosphate levels to be reduced by using *E. crassipes* and *T. cattapa* leaf extract at the location of Abd Canal. Dg. Sirua shows that on the 9th day, using *E. crassipes* can reduce phosphate levels. As for the use of *T. cattapa* leaf extract, the optimal time needed to be able to reduce phosphate levels occurs on the 18th day.

Based on the test results and calculation of the percentage of effectiveness in reducing phosphate levels in wastewater, it can be concluded that the percentage of the effect of the provision of *T. cattapa* leaves on the reduction of phosphate content in domestic wastewater at each location is an average effective monitoring with a decrease that is not too significant. That is, the average value obtained from the results of the effectiveness calculation is influenced by the amount of *T. cattapa* leaf extract given, while the rest is influenced by other factors such as precipitation, temperature rise, and length of stay.
Phosphate is an aqueous solution having low ionic strength makes it possible to form complex bonds with other polymers, especially proteins and acids (Deliberation, 2011) as it is known that *T. cattapa* leaves have various organic acids, where the simple reaction of phosphates with various acids can cause a decrease in phosphate levels due to decomposition into other compounds, such as phosphoric acid or even form other phosphate compounds, depending on the type of acid and the type of phosphate that reacts (Deliberation, 2011). This finding may affect changes in phosphate values in domestic wastewater treated with *T. cattapa* leaves.

Based on the results of research in addition to the optimal dwell time that must be considered in the reduction of phosphate in domestic wastewater, environmental factors where sampling also needs to be considered. Whether community activities or industrial activities around the monitoring location are also indicators of high phosphate levels. When using *T. cattapa* leaf extract, the decrease in phosphate content is relatively stable. This shows that complete absorption of phosphate content in wastewater occurs and also environmental factors at the sampling location. Community activities and industrial activities at the sampling location are still very lacking so that the phosphate content in wastewater is lacking.

5. Conclusion

Based on research that has been done to measure the effectiveness of the use of *E. crassipes* and *T. cattapa* extract leaves in decreasing the acidity of phosphate content in wastewater, it is concluded that the combination of *E. crassipes* and *T. cattapa* leaf extract is effective (significantly influential) in reducing the value of phosphate content. Optimal residence time in reducing phosphate levels by using a combination of *E. crassipes* and *T. cattapa* leaf extract occurred on day 18.

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