

The Effect of Additional Sludge Resulted From Laundry Wastewater in Flocculation – Coagulation Which Used as Mixture of Planting Media in the Growth of Chili Plants (*Capsicum annuum L*)

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Abstract - Laundry services have become a necessity and spread in every city in Indonesia. The number of laundry businesses produces waste containing surfactant (Linear Alkylbenzene Sulfonate/LAS) as an active detergent and phosphate compound (Sodium Tri Poly Phosphate/STPP) to improve washing power efficiency. In this study, the waste was processed by coagulation-flocculation method using PAC coagulant. Processed water becomes cleaner and the resulting sludge which is mixed with soil to be used as a medium for planting Chili plants (*Capsicum annuum L*). The results showed that in the coagulation-flocculation process for 60 minutes with the addition of 100 gram PAC dose, the concentration of LAS decreased from 2.02 mg/L to 0.02 mg/L and the phosphate concentration decreased from 21.994 mg/L to 1.453 mg/L. Planting media with a composition of 95% soil and 5% sludge give the greatest influence on the growth of chili plants.

Keywords: *Laundry wastewater, surfactant, phosphate, coagulation-flocculation, chili plants*

1. INTRODUCTION

Laundry services have become a lifestyle today. Improving air and detergent services produces liquid that can pollute the environment because the waste is discharged into a ditch or water body without prior treatment.

The main content of detergent in the form of anionic surfactants, generally is LAS (Linear Alkylbenzene Sulfonate) to cleanse and process phosphate which serves to eliminate the content of magnesium ions and the ions which present in air and dirt [1,2,3].

Laundry waste processing with the Coagulation-Flocculation method is the most suitable treatment because the method is simple and effective. Coagulation and flocculation are processes in which coarse colloids or

suspended solids from wastewater are stabilized, collected and finally eliminated [4,5].

In this study the sediment from the processing of laundry waste is used to mix plant media because plants have the ability to reduce pollution from organic compounds by mobilizing, decomposing and evaporating depending on the form of environmental pollutants and plant genotypes [6].

2. THEORY

2.1 Laundry Detergent

Laundry detergent is a product that contains surfactants and other ingredients to clean the cloth in washing. Laundry detergent forms are traditionally in the form of solid powder and liquid. The use of laundry detergent liquids has increased gradually over the years, and currently using liquid detergent is the same or even exceeds the use of solid detergents. There are two types of detergent clothing with different characteristics, 1). Phosphate detergent is a type of phosphate containing detergent and is very caustic. 2). Surfactant detergent is a type of detergent that contains surfactants and is very toxic in nature [7].

The substances contained in detergent are 1). Surfactant which is a substance that can reduce the surface tension of water so that it can release dirt that adheres to the surface. Surfactants that are often used in laundry detergents are LAS (Linear Alkyl Benzene Sulfonate). 2). Builder, which is a substance that functions to increase the efficiency of washing from surfactants by deactivating the minerals that cause water hardness. Frequently used builders are Phosphates (Sodium Tri Poly Phosphate/STPP). Both of these substances are the main ingredients of laundry detergent, the other ingredients are 3). Filler substances that can add quantity or can compact. 4) Additives are supplement/supplementary ingredients to make products more attractive, such as fragrances, solvents, bleach, dyes and so on [1,7].

2.2 Coagulation and Flocculation Process

Coagulation is the process of mixing the coagulant with fast stirring to stabilize the colloid and smooth suspended solid, and the core period of the particles, then form a micro floc. Flocculation is a slow stirring step to increase particle size from microfloc and submicroscopic to visible dissolved particles^[4].

The coagulant that is often used is Poly Aluminum Chloride (PAC) with the formula $Al_m(OH)_nCl_{(3m-n)}$. PAC has a high degree of polymerization, a form of inorganic polymer with a large molecular weight. PAC is very well used for water that has low alkalinity which requires removal of color and fast reaction time.

Some of the advantages of PAC are that it is very good for eliminating turbidity and color, is also effective at a wide pH level, activity is not affected by temperature, turbidity will not increase even with excessive doses, use of smaller auxiliaries, savings in the use of neutralization materials and react faster^[8].

Coagulation-Flocculation process :

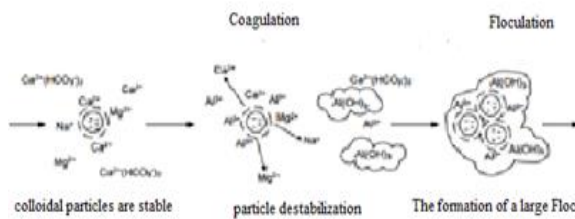


Figure 1.Coagulation-Flocculation process^[8].

2.3. Phytoremediation

Phytoremediation is an innovative technology for environmental cleansing that takes advantage of unique extractive and metabolic capabilities in plants. This technology provides clear benefits compared to traditional methods, including wide application, ecological value and cost effectiveness. In the phytoremediation process organic pollutants can be degraded by plants, and even mineralized [10].

2.4 Chili Plants for Phytoremediation process

Chili belongs to the genus Capsicum (Solanaceae family), which is one of the most cultivated groups in Indonesia. This diverse species is grown worldwide for vegetables, herbs, ornamental, medicinal, and lachrymators use and is a source of vitamin A and C. Capsicum originating from the tropical and subtropical

continents, and the majority of genetic diversity concentrated in Bolivia, Peru, Brazil and Mexico. In general, red chili can be planted in wetlands (rice fields) and dry land (moor). Red peppers can grow well in areas that have an altitude of up to 900 m above sea level, soils are rich in organic matter with a pH of 6-7 and crumb soils. Chili plants have fiber roots suitable for phytoremediation processes. Chili plants in phytotransformation phytoremediation process will change the shape of pollutants so that they are not dangerous and use them as nutrients. Nutrients needed are Nitrogen, Magnesium, Phosphorus, Potassium and Calcium. Phosphate in laundry waste can be used as nutrients in chili plants^[11].

3. RESEARCH METHODOLOGY

Flow Diagram

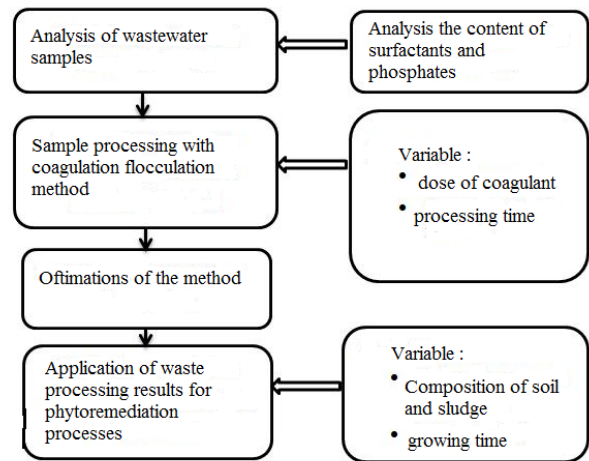


Figure 2. Flow chart of the sample processing process

b) Trial Procedure

This research procedure consists of several stages as follows:

1. Preparation Stage

The preparation stages include preparing tools and materials. The material is taken directly from the place of laundry in the housing of KS and then placed in a container to be used during research.

2. Research Stage

Analyze the initial sample of wastewater before conducting research. Then do sample processing with coagulation flocculation method by adding PAC as a coagulant then stirring it. Next the sample was left idle for some time. After that it separates the water and deposits of the coagulation results into the sample reservoir. Then the sediment produced from

the processing is utilized for the phytoremediation process in chili plants.

3. Analysis Stage

To determine the levels of surfactant and phosphate samples were analyzed using UV-Vis spectrophotometer with method of MBAS (Methylene Blue Active Surface) and Phosphate method.

4. RESULT AND DISCUSSION

4.1 Waste Characteristics

The waste used as the research sample is the residual wastewater from laundry washing in the place named "Laundryku" in the area of Jl. Gunung Gede Damkar Cilegon, this waste physically looks cloudy, smelly, and frothy. The waste was then analyzed by MBAS and phosphate, after analysis was obtained the value of surfactant and phosphate content on the initial sample of laundry laundry waste before being processed was 2.02 mg/L. Government Regulation No.82 of 2001, which is a standard requirement of water quality standards, the maximum LAS content (MBAS) is 0.2 mg/L so that in this study the waste is processed to achieve these standards.

4.2 Effect of coagulant dosage variations on decreasing LAS levels

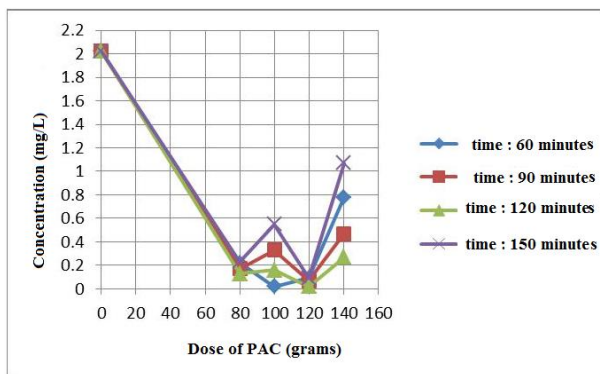


Figure 3. Effect of PAC dose addition on decreased surfactant concentration

Figure 3. Shows that the reduction in maximal concentration occurs in variations in the addition of 100 grams of PAC and 120 grams with a large decrease in concentration reaching 0.02 mg/L. This is due to the destabilization of colloids and particles in these variations.

4.3 Effect of time variation of coagulation-flocculation on decreasing LAS levels

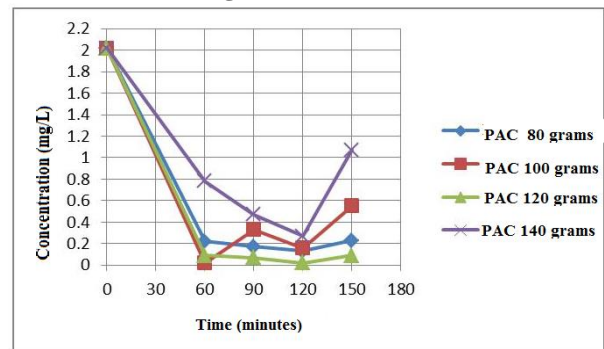


Figure 4. Effect of coagulation-flocculation time on decreasing surfactant concentration

Figure 4. Shows that the longer the processing time, the smaller the concentration of surfactant produced. Decrease in maximum concentration occurs in the variation of coagulation-flocculation time for 60 minutes and 120 minutes with a large decrease in concentration reaching 0.02 mg/L.

4.4 Effect of coagulant dose variation on coagulation flocculation time on LAS level removal

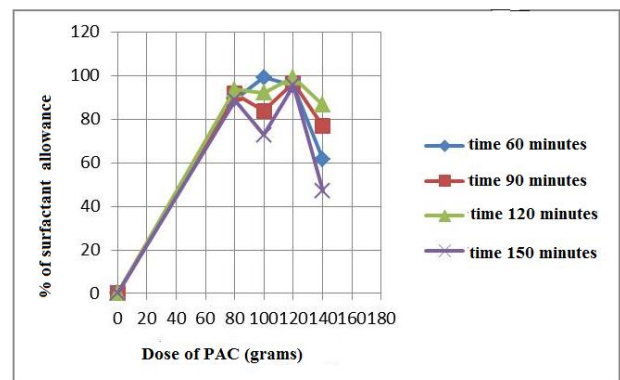


Figure 5. Effect of PAC dose addition on % of surfactant allowance

Figure 5. Showing the highest percentage of allowance obtained from variations in the addition of 100 grams PAC dose at 60 minutes with a large LAS level of 99%.

Based on the experimental results, it can be seen that the greater the decrease in surfactant levels, the greater the % allowance obtained, this is due to the excellent decomposition carried out by Poly Aluminum Chloride (PAC). The addition of coagulant serves to absorb existing pollutants, so that they can be deposited into floc and degraded. The more doses of coagulant added, the greater the ability to absorb pollutants. While the increase in LAS levels due to the ability of the

coagulant that has experienced a saturation point so that it can no longer absorb pollutants in laundry waste. The decrease in surfactant levels is influenced by the destabilization of colloids and particles for various types of pollutants and the contact time between coagulants that is PAC [8].

4.5 Effect of coagulant dose variation on phosphate levels

The use of PAC coagulant in the flocculation coagulation process can reduce the phosphate content in laundry waste [9].

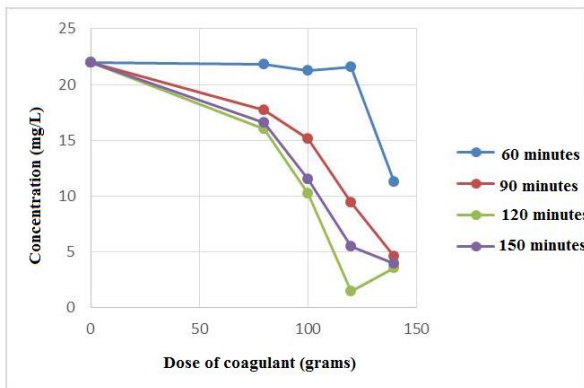


Figure 6. Effect of addition of PAC dose on decreasing phosphate concentration

It can be seen in Figure 6. that at 120 gram coagulant dose with the 90th minute the allowance is maximal. Based on the results of the experiment it can be seen that the effect of the coagulant dose on phosphate levels is very large. This is because the greater the dose of coagulant, the more contact that occurs between pollutants and coagulants, the more floc that is formed, the greater the pollutant separation that occurs. While the increase in phosphate levels is caused by the ability of coagulants that have not reached the maximum point at a certain time so that not all pollutants that can be separated by coagulants [9].

4.6 Effect of time variation of coagulation-flocculation on decreasing phosphate levels

The following is a graph of the results of a decrease in phosphate concentration in laundry wastes in several variations of coagulation-flocculation time.

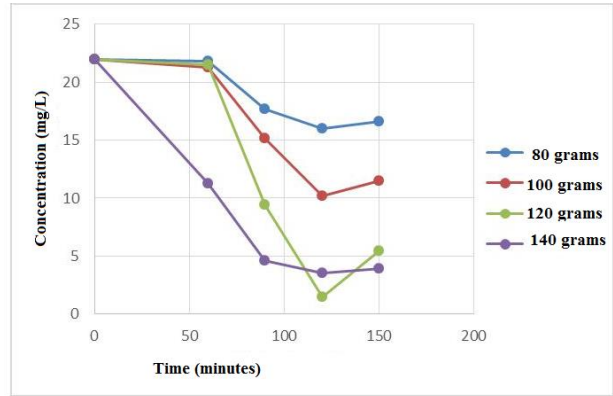


Figure 7. Effect of coagulation-flocculation time on decreasing phosphate concentration

It can be seen in Figure 7. the maximum decrease occurs at 120 minutes with a dose of 120 gram PAC coagulant of 1.453 mg/l. But in this experiment there was a saturation point at 150 minutes at each number of coagulants, where the phosphate concentration value is greater than the phosphate concentration value at 120. At 150 minutes the phosphate concentration was greater but not greater than the phosphate concentration at 60 minutes and 90 minutes.

Based on the results of the experiment, it can also be seen that the dose of coagulant affects the decrease in phosphate concentration. The maximum decrease in phosphate concentration occurs at 120 grams of coagulant dose at 120 minutes, although at 150 times it has a greater concentration. At the 60th, 90th and 150th minute the largest decrease in phosphate concentration occurred at a coagulant dose of 140 grams.

The effect of time variation of coagulation-flocculation on the reduction of phosphate concentration is very large, this is because the decomposition carried out by coagulant is very good. The greater the dose of coagulant given, the greater the particle contact will occur and the more formed floc will cause larger particles to be separated, including phosphate in it. While the increase in phosphate levels due to saturation point occurs in the coagulant at a certain time where the coagulant can no longer decompose pollutants in laundry waste. At the 150th minute the coagulant has a saturation point, it can be seen in the graph that the maximum reduction in phosphate levels occurs at 120 minutes with a dose of 120 grams of coagulant. While the increase in phosphate value is due to the ability of the coagulant that cannot absorb the pollutants in laundry waste anymore.

4.7 Effect of coagulant dose variation on coagulation flocculation time on phosphate level removal

The following is a graph of the results of a decrease in phosphate concentration in laundry waste in several variations of the addition of coagulant.

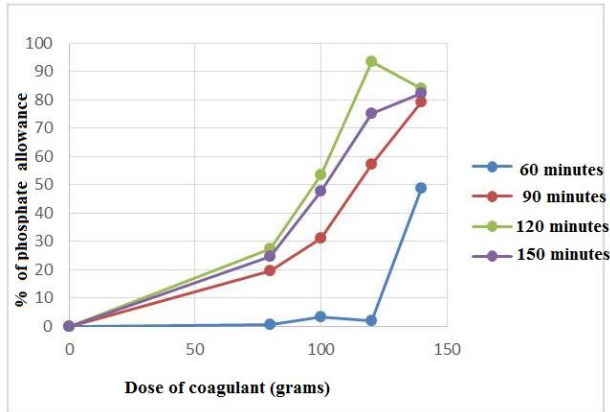


Figure 8. Effect of addition of PAC dose on % of phosphate allowance

It can be seen that the phosphate removal that occurs in each coagulant addition does not always increase. Phosphate removal at 80 grams of coagulant dose at 120 minutes was 26.81%, while 80 grams coagulant at 150 minutes was 24.59%. Likewise the phosphate removal at 140 grams of coagulant dose at 150 minutes was 82.19, while at 140 grams coagulant dose at 120 minutes was 83.95%. This is because the coagulant at that time has experienced a saturation point, where the coagulant can no longer decompose pollutants in the laundry waste.

Based on the results of the experiment it can be seen that the greater the decrease in phosphate levels, the greater the % allowance obtained, this is because the decomposition carried out by coagulants well. At high coagulant doses, the phosphate removal is greater. This is because the greater the dose of coagulant contact between particles that occurs will be greater and the floc formed becomes more and more which causes greater phosphate removal that occurs. While the increase in phosphate levels occurs because the ability of the coagulant to experience a saturation point so it can no longer absorb pollutants [9].

4.8 Effect of coagulation-flocculation time variation on coagulant dosage addition on phosphate levels removal

The following is a graph of the results of a decrease in phosphate concentration in laundry wastes in several variations of coagulation-flocculation time.

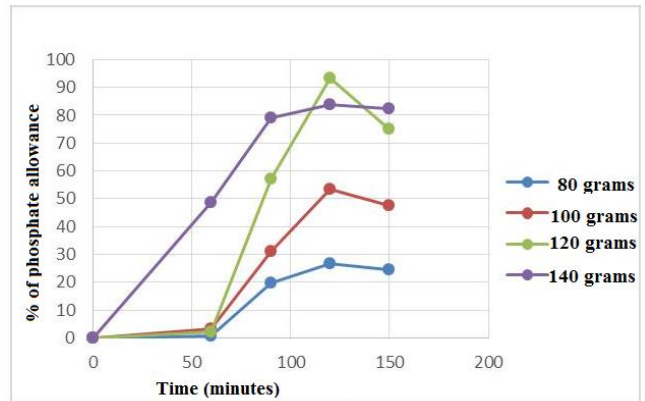


Figure 9. Effect of coagulation-flocculation time on % of phosphate allowance

Based on the results of the experiment, the maximum value of phosphate removal occurred at 120 minutes at 120 grams of coagulant dose of 93.393%. While the lowest allowance was at 60 minutes at 80 grams of coagulant dose of 0.718%.

The longer the time used, the greater the phosphate removal. This is because the longer the time used, the ability of the coagulant to absorb pollutants will be better and maximum. Can be seen in the allowance graph above the longer the time used, the greater the percentage of allowance that occurs. But at the 150th minute there is a saturation point where the coagulant is no longer able to absorb pollutants in the waste so that the % allowance is not optimal.

4.9 Effect of Time of Planting Media Contact on Chili Plant Growth

This experiment was conducted to determine the effect of adding sediment from laundry waste processing to the growth of chili plants. The research was carried out by adding sediment to chili plants then observing the changes. Observations are carried out every 5 days for 20 days. Changes observed were the height of the stem and the number of leaves on the chili plant. The growth of chilli plants on fertilizer application (NPK) and sediment from different laundry wastes shows good results. The samples of chilli plants that are used are different so that the height of the plant and the number of leaves of the chili plant are also different. The following variations are used in the application of laundry waste deposits that have been determined, namely:

Sample	Soil	Sludge	NPK
1	95 %	0	5 %
2	90 %	5 %	5 %
3	91 %	4 %	5 %
4	92 %	3 %	5 %
5	93 %	2 %	5 %
6	94 %	1 %	5 %
7	95 %	5 %	0
8	97 %	3 %	0
9	99 %	1 %	0

4.10 Effect of Time of Planting Media Contact on the Height of Chili Plant Stems

From the observations showed good growth in chilli plants. This can be seen from the data generated increases. Although when the first day to the fifth day the height of the chili plant stem had not changed, then on the 10th day the average height of the chili stems began to rise from the initial height. Then the observation continued until the 15th day, but the height of the chili plant stems did not show an increase. Then in the observation of the 20th day the height of the stem has increased again.

The following graph data is the result of observations of differences in the height increase of chili plant stems for 20 days for each variation of the planting medium.

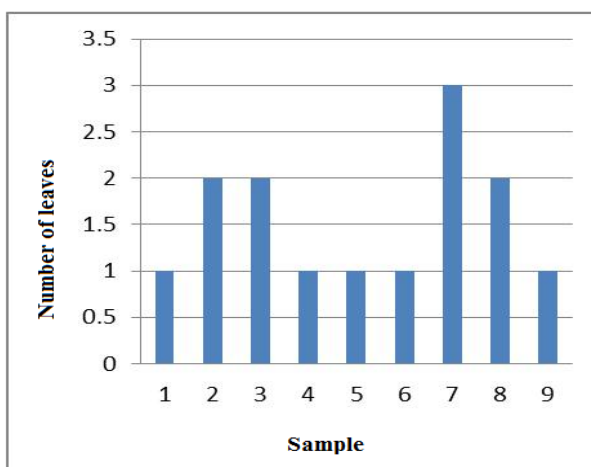


Figure 10. Effect of contact time on stem height

The resulting data shows the highest difference in the growth of chilli plants, namely in sample 7 with the addition of sediment produced by laundry waste as much as 5% (5 g), the difference obtained from the height of the chili plant stems from the beginning to the end is 3 cm. In contrast to other samples whose difference is smaller than the sample 7. This can be caused by the influence of phosphate content on sludges that are high enough to meet nutrient requirements of chili plants [11].

Nutrients needed for plant growth, especially the height of the stem, work optimally. The existence of the P element serves as a storage and transfer of energy for all metabolic activities of the plant, so that the presence of element P will accelerate the growth and development of the root tips and growing points on the plant. So that it can be concluded that the P element in plants works optimally so that the height of the chili plant stems increases with time [10].

4.11 Effect of Contact Time on the Leaves of Chili Plants

In addition to plant height, other variables observed were the number of leaves on the chilli plant before and after the addition of sediment resulting from the processing of laundry waste. The number of initial leaf chili plants used varies.

From the results of the observations showed the growth of the addition of a good number of leaves on chili plants. It can be seen from the results of the observation that the number of leaves on the chili plant increased within 10 days. On the observation of the first day to the fifth day the number of leaves on the chili plant has not shown a change and the number of leaves still remains. Then on the 10th day the average number of chilli leaves began to increase from the initial number. Then the observation continued until day 15, but the leaves did not increase again. After observing the 20th day the number of leaves on the chili plant again showed an increase in the number of leaves. The leaves that appear are still in the form of leaves or small shoots that are still very young.

The following graph data from the observation of the difference in the addition of leaves on chili plants for 20 days for each variation of the planting medium.

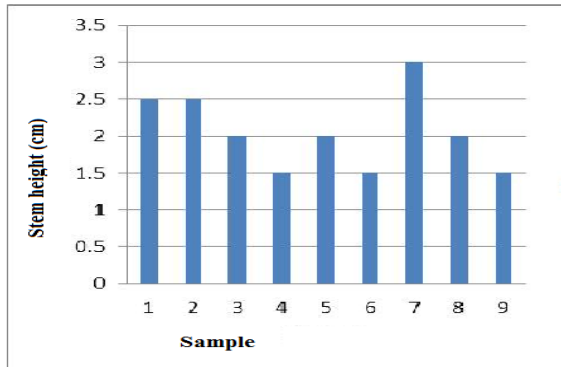


Figure 11. Effect of contact time on the number of leaves

The resulting data shows the highest difference in the number of leaves added to the chilli plant, which is in sample 7 with the addition of 5% sludge resulting from laundry waste processing (5 g), the difference obtained from the number of leaves of chili plant from the beginning to the end is 3 pieces. Different from other samples, the difference is smaller than sample 7. This is due to the presence of nutrients that work optimally to trigger the increase in the number of leaves on the chili plant. Sufficient P application increased plant height, shoot biomass, tiller number, and panicle dry weight compared to that of no P fertilization in both two years' studies^[12]. The concentration of P on the leaves has increased with increasing doses of P fertilizer application. This is in accordance with the data obtained from the observation that the addition of deposits resulting from the processing of laundry wastes affects the growth of the number of leaves and height of stems on chili plants that are quite good.

5. CONCLUSION

1. Laundry waste treatment process with coagulation-flocculation method with time variation and coagulant dosage succeeded in reducing detergent content in laundry waste with different levels of each variation.
2. The highest percentage of LAS removal was 99.009% at 60 minutes with a coagulant dose of 100 grams, while the highest percentage of phosphate removal was 93.393% at 120 minutes with a coagulant dose of 120 grams.
3. The phosphate content contained in the processing sludge can be used as a planting medium for chili plants. The best growth of the best chilli plants is 3 cm in the composition of 95% soil and 5% sludges, while the best leaf growth is 3 pieces in the composition of 95% soil and 5% sludges.

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