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A Study of Centrifugation Technology for Reducing Microbial Contamination in Surface Water Sample

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Abstract. Cikarang is the largest industrial city in Southeast Asia, making it particularly susceptible to pollution and a decline in the quality of river water. Wastewater from industry, medical waste, and other sources is discharged into the Cilemhabang River, which is black and smells rotten. Monitoring and analyzing data on water quality can help determine the extent of industrial activity-related pollution and the capacity of river water flow to mitigate pollution. The environment, particularly river water resources, can be preserved by further evaluation actions. **Objectives:** To test for biological parameter in water after centrifugation treatment, the TPC method is used. Centrifugation is a separator that utilizes the difference between the effects of centrifugal force on each molecule of a substance. The examination seeks to reveal the quantity of microorganisms that proliferate and cluster into colonies. **Method and results:** This study is a laboratory scale research using a centrifuge as the main tool. River water was treated at 6000 rpm and centrifuged 1 minute duration without the addition of Kaolin. And this research was conducted to further develop centrifugation equipment as an alternatives treatment and to determine the biological parameters of the samples after using centrifugation **Conclusion:** The result is in removal efficiency in the range of 81% - 83% for the turbidity parameter and 18% - 28% for the Total Plate Cont of microbial removal. Based on statistical tests using paired T-test, it has a large effect for reducing microbe although it still shows below the quality standard.

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1 Introduction

The issue of water pollution in the Cilemahabang River caused by various activities on its right and left proves that the river's water quality of BOD (Biochemical Oxygen Demand) does not meets the criteria for being designated as standard of clean water for sanitation in accordance with Government Regulation No. 32 of 2017 which refers to the parameters for Swimming Pool Water Media table 4 point 2 namely turbidity and also table 5 point 2 namely Heterothropic Plate Count (HPC) and it is probably derived from domestic waste from residential activities like bathing, washing, and so forth, increasing the amount of organic matter in the river[1].

Previous research stated that the average BOD value of Cilemahabang River from 2018-2020 was approximately 35 mg/L, it proves that the BOD in Cilemahabang River water is higher than the quality standard of Government Regulation No. 22 of 2021 about River Water Quality Standards Class 1[1], and it is indicate that river water contain high of microorganism. Since the river water flows from upstream to downstream toward the estuaries, the microorganisms present in it are transported by the stream flow. The term "BOD" refers to "Biochemical Oxygen Demand," and it indicates that a certain quantity of dissolved oxygen is needed for deep organic matter to breakdown under aerobic circumstances by microbes (often bacteria)[2]. Bacterial growth is strongly influenced by BOD (Biological Oxygen Demand). In instances where the BOD level increases, coliform growth will also increase. Therefore, high BOD levels in water indicate a high microbial concentration the rein [3]. For more optimal development, this is a continuous research where there has been previous research entitled "The Study of Centrifugation Technology in Ablution Wastewater Treatment to Reduce Turbidity and Total Suspended Solid"[4]. Previous research have tried to see the results of physical parameters and optimal conditions for using centrifugation and it was concluded that the optimal centrifugation device at a speed of 6000 rpm in 1 minute to reduce Turbidity and Total Suspended Solids with the addition of coagulants in the sample.

The final goal of this study in the future is proving that centrifugation may reduce suspended particles in surface water. Therefore, in this research river water samples were used as one of the indicators for this research, although this will obviously require more research or development because the method now being utilized to produce clean water from surface water such as desalination, a method that comprises filtration, distillation, and ion exchange procedures, can be used to treat saltwater. Using a mixture of neutralization, coagulation, and filtering to treat peat-containing acidic water. Coagulation and filtration are used to treat fresh water with a high turbidity level[5]. Therefore, this research was developed so that centrifugation technology can be an alternative which has not been generally used to reduce suspended particles in the future for more advanced wastewater treatment such as cosmetic waste or other types of waste so that it becomes cleaner water.

2 Research Methodology

2.1 Scope and Limitation

2.1.1 Scope

1. This project's topic focuses on the Cilemhabang river water that has undergone centrifuge treatment in a Laboratory of the Faculty of Engineering President University

2. The biological parameter, specifically the Total Plate Count, is the parameter of the subject under discussion

2.1.2 Limitation

1. Samples were taken from the middle of a bridge near President University (6°17'01.7"S 107°10'12.9"E) in Cilemahabang River, North Cikarang, Bekasi Regency in January 2023

2. Sampling was carried out 3 times in the morning and sampling was carried out using a lab instrument, namely a horizontal water sampler.

2.2 Research Framework

The research framework is a series of research processes, starting from finding research ideas to analyzing the results of the discussion and conclusions. The research framework for this final project can be seen in the research flowchart below. Problems are determined or identified beforehand, in line with the collection of literature to support the hypotheses in this study. To start the research, a grab sampling approach was used to take river water samples and also to prepare artificial water samples. Then the instruments and equipment for the experiments in this study must be prepared. Samples were treated twice; The first is an experiment without using a centrifuge, with turbidity and the number of microbial colonies as parameters. The second treatment was an experimental experiment using a centrifuge, with turbidity and the number of microbial colonies as parameters. The findings of the second treatment will be analyzed. The data will be evaluated as a whole using statistical and other analytical methods. The final data will be evaluated to get the conclusions of this study.

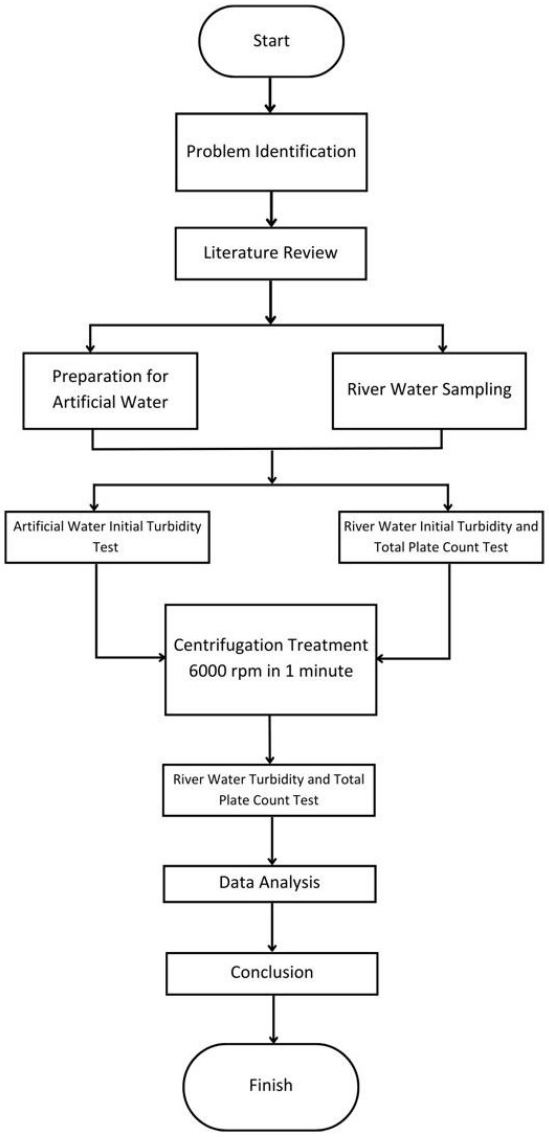

Fig. 1 Research Framework

2.3 Sample Preparation

In order to ascertain whether or not there was a decrease in the amount of microbes in river water treated with a centrifuge, this research was using primary data in the form of water quality data that was carried out through experimental methods in the laboratory. A centrifuge with a maximum rotational speed of 6000 rpm was used to conduct the experiment on a lab scale for one minute. Standard parameter test methods were used in the laboratory to analyze parameters as well. The testing period's implementation is designated for January 2023. Water samples taken in the middle of a bridge near President University (6°17'01.7"S 107°10'12.9"E) Cilemahabang River that located in Simpang Village, North Cikarang District, Bekasi. Sampling was carried out in the morning and sampling was carried out using a lab instrument, namely a horizontal water sampler. Then the sample is

transferred and put into a storage container in the form of a gallon. The samples were transported right away to the laboratory for analysis at the Laboratory of the Faculty of Engineering, President University. The sampling method used in this research was based on SNI 6989.57:2008. The process for the river water collection point is then carried out in compliance with SNI 6989.57.2008, which states that a sample must be taken at a single point in the middle of the river at a depth of 0.5 times the surface or using a horizontal water sampler to ensure that water samples are taken evenly from the top to the bottom[6].

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2.4 Tools and Materials

Tools and materials were utilized in order to accomplish this research experimentally in the lab. The turbidity of river water will first be examined through an experiment. The second is the separation of molecules in samples. Third, knowing the reduced number of microbes in river water because based on the results of the quality of Cilemhabang river water which shows high BOD contamination indicating the presence of microorganisms is high and also identifying for biological parameter.

a. Tools

B-ONE Centrifuge DC 6015-12	Analytical balance
Turbidity Meter EUTECH Model TN 100	Watch glass
Test tube	Spatula
Petri dish	Horizontal water sampler
Pipette 1 ml	Test tube 15 ml
Pipette 10 ml	Autoclave
Bunsen	Incubator
Erlenmeyer 250 ml	Marker
Magnetic strirer	Lighter

b. Materials

1. PCA (Plate Count Agar)
2. NaCl solvent
3. Alcohol 70%
4. Aquadest
5. River water sample

2.5 Data Analysis

The effectiveness of decreasing the level of turbidity can be assessed through comparison of influent and effluent and is represented by a percentage after carrying out experiments and collecting the data on parameters. The following formula can be used to determine removal efficiency[7]:

Removal efficiency (%) = $\frac{(A-B)}{A} \times 100\%$

Note,

A = Initial concentration of the parameter

B = Final concentration of the parameter

For parametric statistical analyses, the T-test is a test approach. The t statistical test is a measurement of the extent to which the impact of a single independent variable on its own explains the dependent variable[8]. Statistical analysis 0.05 ($\alpha = 5\%$) is used as the significance threshold for the t or t-test. The comparison hypothesis of more than two samples, each sample consisting of two or more species collectively, is tested using a two-way ANOVA

3 Result and Discussion

3.1 Initial River Water Characteristic

The outcomes of the water sample taken from the Cilemahabang River were then analyzed in laboratory of the Faculty of Engineering at President University to identify the characteristics of the water. Table 2 below shows the qualities of river water:

Table 1 Actual River Water Characteristic

	Date	Result	Standard	
Turbidity (NTU)	24 Jan 23	26.5	0.5*	x

28 Jan 23	25.7
30 Jan 23	19.15

Note:

x Not comply to the standard

* Environmental Health Quality Standards in the Minister of Health Regulation No.32 of 2017 about Environmental Health Quality Standards And Water Health Requirements For Sanitation Hygiene Purposes, Swimming Pools, Aqua Solutions And Public Bathers

The study of the characteristics of the Cilemahabang river water resulted in the table above, which illustrates that the turbidity of the river water does not match the clean water quality standards if referring to the Regulation of the Ministry of Health of the Republic of Indonesia No. 32/2017. But when compared to the Citarum River, the Cilemahabang River has a lower turbidity level, with the Citarum River's turbidity level reaching 214 NTU[9] while the sampling location for the Cilemhabang River is at a point a little away from residential areas and there are no activities like bathing, washing, and others.

Table 2 Inoculation Result Before Centrifuge

Inoculation Results 1 (24 January 2023)		Standard
Dilution Level	(CFU/mL) Before Centrifuge	
10^(-1)	1470	
10^(-2)	1030	
Inoculation Results 2 (28 January 2023)		
Dilution Level	(CFU/mL) Before Centrifuge	*100 CFU/ 100 mL
10^(-1)	2683	
10^(-2)	1757	
Inoculation Results 3 (30 January 2023)		
Dilution Level	(CFU/mL) Before Centrifuge	
10^(-1)	2917	
10^(-2)	1630	

Note:

* Environmental Health Quality Standards in the Minister of Health Regulation No.32 of 2017

Then for the results of the number of colonies in the sample it also shows the result that the river water does not meet the standard, which is above 100 CFU/100 mL

3.2 Experimental Result

3.2.1 Preliminary Experiment

Preliminary experiments involve using a centrifuge to treat river water. The purpose of this experiment is to determine the percent removal in reducing turbidity in river water for one minute. The experimental results are listed in the table below:

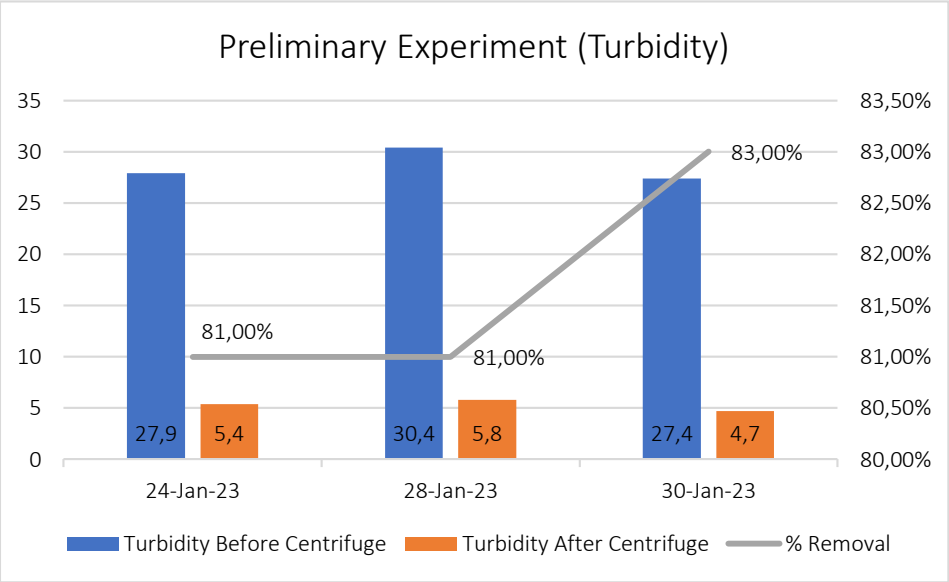

Fig. 2 Preliminary Experimental Result

Based on the test results above, it shows that from the experiment, namely centrifugation of the sample at a speed of 6000 rpm, duration of 1 minute produced turbidity levels that remained below the quality standard. If look at the purpose of the experiment above to find out the average percent removal, the results shown are between 81% to 83% but the turbidity results did not meet the quality standards of the RI Minister of Health No. 32/2017.

3.2.2 Turbidity Result of Artificial Water Samples

Experiments on the turbidity parameters of artificial water samples that made from kaolin and distilled water mixture were carried out to prove the most optimal removal efficiency of turbidity levels that can be processed by a centrifuge treatment for 6000 rpm in 1 minute and the results are presented in tabular form. The results are presented in terms of kaolin doses of 5 mg/L, 40 mg/L, 70 mg/L, 144 mg/L, and 181 mg/L respectively to achieve the desired level of turbidity.

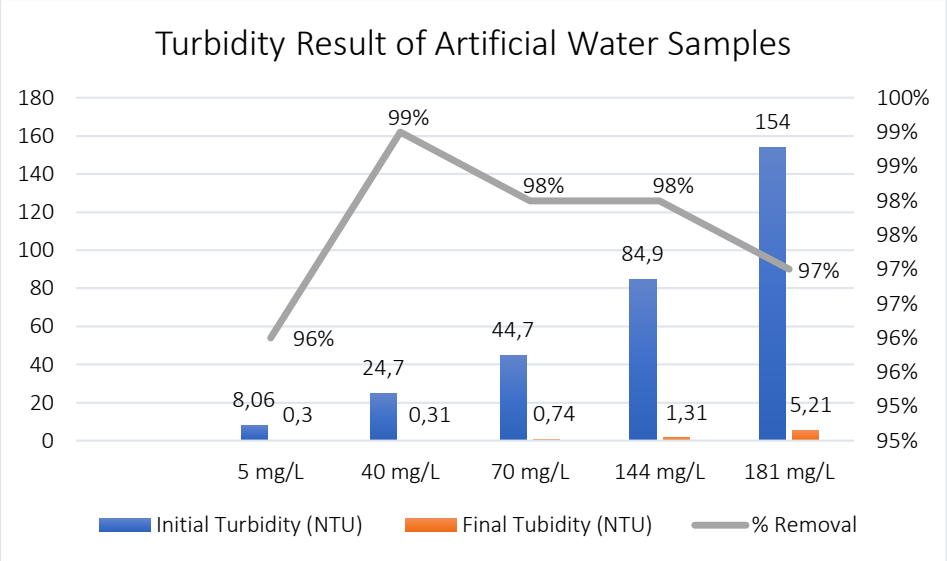

Fig. 3 Turbidity Result by Artificial Water Samples

The findings of the turbidity parameters of artificial water samples treated using a centrifuge are shown in the table above. With kaolin doses of 5 mg/L, 40 mg/L, 70 mg/L, 144 mg/L, and 181 mg/L. The percentage of turbidity reduction was around 96% from the initial turbidity with a turbidity level of 8 NTU. The effectiveness of reducing turbidity increases if the initial turbidity level is around 20 NTU, which is 99%. However, the optimal level of turbidity reduction using centrifugation decreases as the initial turbidity level increases. This shows that the optimum level of turbidity reduction that can be produced after going through the centrifugation process is around 20 NTU. For this reason, there is no need to add kaolin as an coagulant aid to the Cilemahabang River water sample because the initial turbidity is already in the range of 20 NTU. This is due to the reason that the effect of separating suspended particles in the centrifugation removal procedure that uses centrifugal force is influenced by the mass of each suspended particle in the sample[4]. In addition, when the particles in the sample have a mass that is too low, the particles do not have the ability to separate themselves from the liquid and if the turbidity in the sample decreases, the microorganism content also decreases, because microorganism is the suspended content in the sample., so the addition of kaolin as a coagulant aid is taken into consideration.

3.3.3 Microorganisms Removal Result of River Water Sample

The results of the experiment below on the number of bacterial colonies contained in the Cilemahabang river water have been processed using a centrifuge and presented in tabular form. The results are presented in the state before being processed using centrifugation, after being processed using centrifugation and the inoculation process was repeated three times in a row, thus showing the results of interactions before and after the sample was processed using centrifugation as a factor.

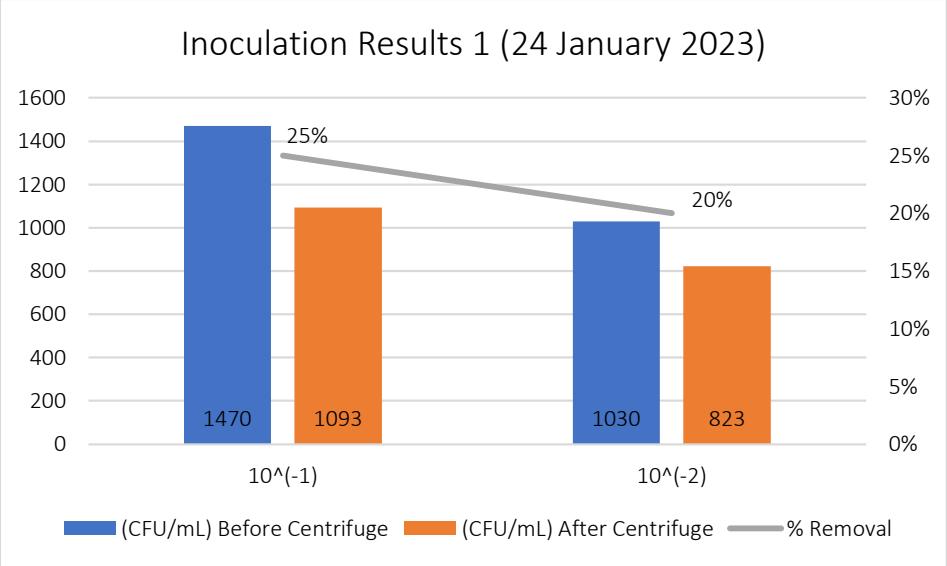

Fig. 4 Numbers of Bacterial Colonies of Total Plate Count Inoculation 1 (24 January 2023)

The table above where the results of the first inoculation on January 24 2023 shows that at the dilution level 10^{-1} the percent removal rate produced between before and after the centrifugation process is 25%, while at the dilution level 10^{-2}. The percent removal is 20%. Then the number of colonies before the centrifugation process at the two dilution levels is also different because the concentration at the dilution level 10^{-2} is thinner than the dilution level 10^{-1} which causes the number of colonies to be different.

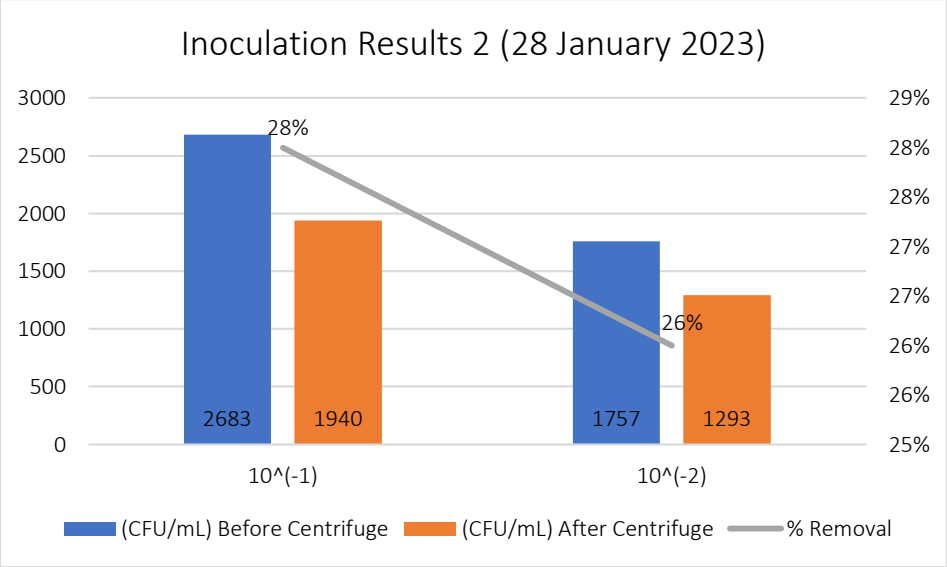

Fig. 5 Numbers of Bacterial Colonies of Total Plate Count Inoculation 2 (28 January 2023)

The table above which shows the results of the second inoculation on January 28 2023 shows that at the dilution level 10^{-1} the percent removal rate produced between before and after the centrifugation process is 28%, while at the dilution level 10^{-2}. The percent removal is 26%. Then the number of colonies before the centrifugation process at the two dilution levels is also different because

the concentration at the dilution level 10^{-2} is thinner than the dilution level 10^{-1} which causes the number of colonies to be different.

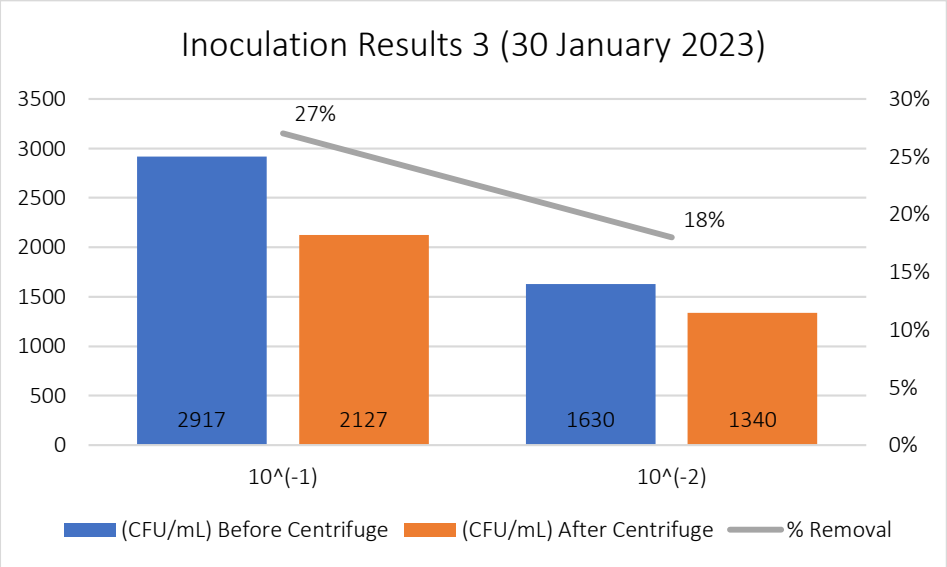

Fig. 6 Numbers of Bacterial Colonies of Total Plate Count Inoculation 3 (30 January 2023)

The table above which shows the results of the third inoculation on January 30 2023 shows that at the dilution level 10^{-1} the percent removal rate produced between before and after the centrifugation process is 27%, while at the dilution level 10^{-2}. The percent removal is 18%. Then the number of colonies before the centrifugation process at the two dilution levels is also different because the concentration at the dilution level 10^{-2} is thinner than the dilution level 10^{-1} which causes the number of colonies to be different.

Therefore, findings from the results of inoculation with the Total Plate Count method before being treated using centrifugation and after being treated using centrifugation resulted in a percent removal below 50% or the level of microorganisms in the water content of the Cilemhabang River was not reduced by half from the initial content even though it had been treated using centrifugation.

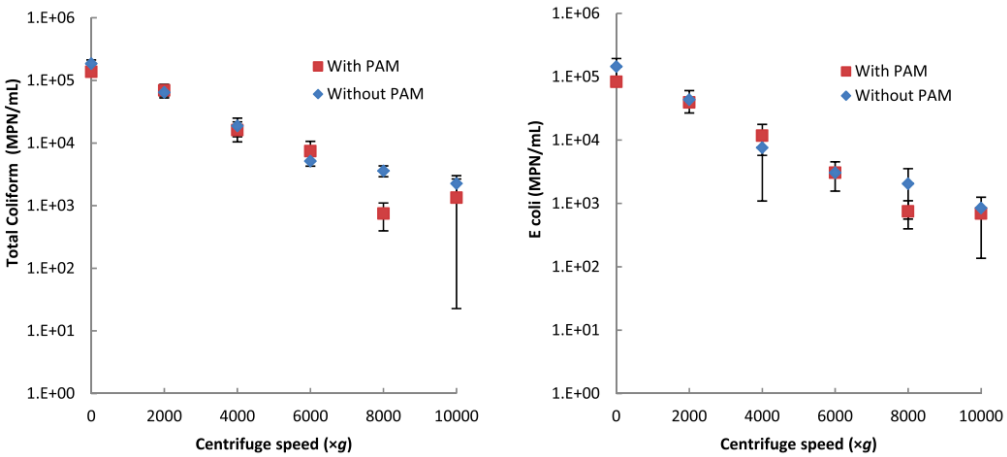

Fig. 7 Total coliform and E. coli in manure with increasing centrifuge speed[10].

Based on the aforementioned studies, it can be concluded that using a centrifuge to separate solid particles from suspended liquids could reduce the pathogens present in manure and also these results are relevant to centrifugation which can reduce microorganisms in surface water. This happens because the driving force behind centrifugal separation is caused by the different densities of the solid particles and the suspended liquid. Aside from the fact that bacteria may be affected by shear forces and collisions with suspended particles when centrifuging, the particles in dirt samples that are easiest to separate are larger and heavier than bacteria[10]. It might potentially occur when there are heavier particles in river water that remain undissolved, causing a higher level of cell damage

4 Conclusion

In order to decrease the turbidity parameters and microbial colonies, the optimal quality standards are compared to the best ones that can be obtained. The outcome is that centrifuging river water without the addition of kaolin as a coagulant aid is the most efficient for both criteria. Based on the results of the statistical analysis of the Paired T test, the centrifugation treatment affected the turbidity and the number of bacterial colonies in river water. In ANOVA result, the centrifugation treatment has an affect for the numbers of microbes in sample and for time of treatment has no effect for numbers of microbe in sample.

5 Aknowledgement

In organizing this journal review, I want to offer my thanks to Sir Rijal Hakiki S.S.T., M.T. for his direction in this work. I truly mindful that this journal is a long way from an ideal journal. However, I trust that this work can be valuable for myself and furthermore for the perusers.

6 References

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