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ANALYSIS OF WATER TURBIDITY REMOVAL OF SURABAYA RIVER USING THE COAGULANT OF PAPAYA SEED POWDER AND PAPAYA SEEDS

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ABSTRACT

Water is a source of life for human survival and very important for sustainable development. Therefore, clean and safe drinking water is essential for human life. Increasing wastewater from industrial, domestic, and agricultural activities will have an impact on increasing river water pollution as raw water for drinking water. This study aims to determine the ability of papaya seeds as natural coagulants in the form of powder and seeds to reduce turbidity levels (NTU) of Surabaya River water which is raw water for drinking water of Surabaya city residents. The research method used in this study was an experimental laboratory method for the coagulation process of flocculation using a jar test with coagulant dose variations and pH. The results of this study concluded that the coagulant of papaya seeds with a dose of 0.3 g / L at pH 3 could remove the turbidity of Surabaya River of 99.92% from 1235 NTU to 7.11 NTU. The powder coagulant of papaya seeds at a dose of 0.2 g / L at pH 3 could remove the turbidity of Surabaya River of 99.94% from the initial turbidity of 1235 NTU to 9.82 NTU.

KEY WORDS : Surabaya river, Papaya seeds, Turbidity, Removal efficiency.

INTRODUCTION

Water is a source of life for human survival, and it is very important for sustainable development. Hence, clean and safe drinking water is essential for human life. The rapid industrial, domestic, and agricultural activities will have an impact on the increase of wastewater discharged into rivers and will increase river water pollution. Surabaya River, as a source of raw water for drinking water of Surabaya city residents, has also experienced pollution for 30 years to date (Razif and Persada, 2015a). The river water discharge factor also has a significant effect on river water quality parameters (Razif and Persada, 2015b). The results predict that the water quality of the Surabaya River still indicates severe polluted conditions (Razif *et al*., 2018). The water pollution of Surabaya River is inseparable from the non-functioning of the Wastewater Treatment Plant (Razif *et al.,* 2015c) because the fluctuations of treated wastewater quality cannot be overcome (Razif *et al.,* 2015d) and another concern is about the costs of operating and maintenance issue (Razif *et al.,* 2015e). If a Waste Water Treatment Plant can be implemented properly, river pollution can be reduced (Razif *et al.,* 2014). The water turbidity level of Karangpilang Drinking Water Installation in Surabaya City was reduced by the chemical coagulant Al2 (SO4) 3 and PACl in the coagulation-flocculation process. The use of chemical coagulants is very effective, but the operational costs for purchasing coagulant materials are quite expensive. Besides, aluminum residues remain in the treated water and sludge produced (Katrivesis *et al*., 2019). Coagulants are added in order to reduce the electrical charge among the suspended particles and respectively in flocculation, flocculants are added to enhance the collision and the growth of flocs (Katrivesis *et al*. (2019). Moringa natural coagulant has been used for textile industry wastewater and

produces color removal of 83.05% and COD removal of 78.4% (Dotto *et al*., 2018). *Salvia hispanica* has been used to treat leachate and can reduce COD by 39.76% and turbidity by 62.4% (Tawakkoly *et al*., 2019). *Quercus robur* has also been tried as a natural coagulant for turbidity removal (Antov *et al.,* 2018). Flower extract *Musa sp* has also been used as a natural coagulant for the flocculation coagulation process to reduce turbidity (Vas *et al*., 2018). *Cicer arietinum* has also been used as a natural coagulant and flocculant and can reduce turbidity, COD, and TSS by 86%, 56%, and 87% respectively (Lek *et al*., 2018). Natural coagulants are also potentially used to reduce the concentration of certain pollutants, one of them is papaya seeds (Aprilion *et al*., 2015). Papaya (*Carica papaya L.*) is a fruit plant from the family of *Caricaceae* originating from Central and West Indies, and in the area around Mexico and Costa Rica. Papaya plants are widely planted by people, both in tropical and sub-tropical regions, in wet and dry areas or plain and mountainous regions. In this study, papaya seeds were used as natural coagulants in powder and seeds. This study aims to determine the ability of papaya powder and seeds as natural coagulants to reduce turbidity levels (NTU) of Surabaya River water by coagulation-flocculation with coagulant dosage variations and pH.

RESEARCH METHODS

This research was conducted using a laboratory test instrument in a laboratory with natural coagulants, namely papaya seeds. Papaya seeds were made into powder and remained as papaya seeds with a concentration of 0.05 g / L , 0.1 g / L, 0.2 g / L, 0.3 g / L, 0.4 g / L and 0.5 g / L with initial turbidity of 1235 mg / L. The coagulation process was carried out by fast stirring of 100 RPM for 1 minute. Then, a flocculation process was carried out with slow stirring of 50 RPM for 15 minutes, and the sedimentation process was carried out for 30 minutes before sampling for turbidity measurement (NTU) was taken. From this study, the optimum dose was obtained from the highest removal efficiency. From the optimum dose, it was then followed by pH variations of 3, 5, 7, 9, and 11 to find the optimum pH at the optimum dose.

RESULTS AND DISCUSSION

The water used in this study was Surabaya River water taken near the intake of the Karangpilang Drinking Water Installation. After the water was examined in the laboratory, the characteristics are shown in Table 1.

The preliminary research was conducted to determine the optimum dose of coagulant. Optimization of the coagulation mechanism of flocculation is strongly influenced by particle size that will be made floc (Sun *et al*., 2019). As long as there is no equipment to measure colloidal particles in Surabaya River water, the study on optimum dose determination by performing dose variables needs to be done. The results of determining the optimum dose are shown in Table 2 for papaya seeds and in Table 3 for papaya seed powder.

The optimum dose for papaya seed coagulant is 200 mg/L (0.2 g/L) as seen in Table 2 and the optimum dose for papaya seed powder coagulant is 300 mg/L (0.3 g/L) as seen in Table 3.

Variation in dosage

Preliminary research with this dose variation is intended to find the optimum dose that will be used for research with pH variations. The measurements results of removal efficiency from dose variations for papaya seeds and papaya seed powder are

Table 1. Characteristics of Surabaya River Water and its quality standards

No.	Parameter	Unit	Result	* Quality Standards 1	** Quality Standards 2
1.	Turbidity	NTU	1.235	25	5
2.	Color	TCU	100	50	15
3.	TDS	Mg/l	1600	1000	500
4.	Temperature	^{0}C	32^{0}C	Air temperature ± 3	Air temperature ± 3
5.	Taste	-	-	Tasteless	Tasteless
6.	Smell	-	Smelly	Odorless	Odorless
7.	pH	-	7,5	7-8	7-8

* Quality Standards 1: Minister of Health (2017)
** Quality Standards 2: Minister of Health (2010)

Table 2. Determination of the optimum dose of Papaya Seeds

No.	Papaya seeds		
	%	mg/L	NTU
1	25	50	43.28
2	50	100	25.62
3	75	150	36.41
4	100	200	22
5	125	250	34
6	150	300	32
7	200	500	51.28

Table 3. Determination of the optimum dose of Papaya Seed Powder

No.	Papaya seed Powder		
	%	mg/L	NTU
1	25	75	19.39
2	50	150	19.43
3	75	225	20
4	100	300	18.68
5	125	375	25.71
6	150	450	36.37
7	200	600	84.7

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shown in Figure 1 and 2.

From Figure 1, it can be seen that the dose of 0.3 g/L is the maximum removal efficiency for papaya seeds and from Figure 2, it can be seen that the dose of 0.2 g/L is the maximum removal efficiency for papaya seed powder. Thus, the optimum dose in the preliminary study for papaya seed coagulant is 0.3 g/L while for papaya seed powder coagulant is 0.2 g/L.

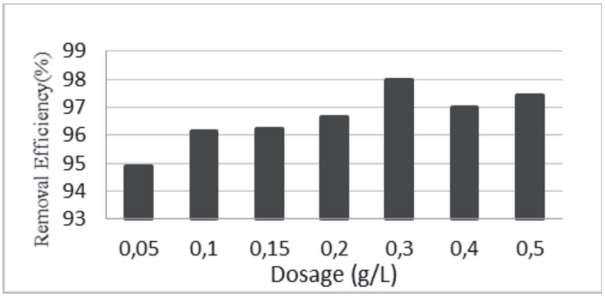

Fig. 1. Removal efficiency of turbidity with papaya seed coagulant

Variation in pH

After the optimum dosage was determined, the research was conducted again with pH variations. The pH variations in this study were 3, 5, 7, 9, and 11 with initial turbidity levels of 1235 NTU. The

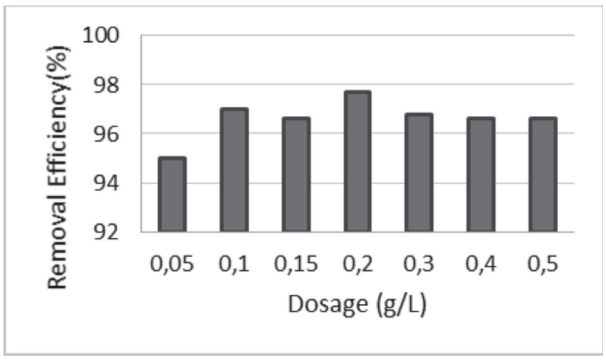

Fig. 2. Removal efficiency of turbidity with powder coagulant of papaya seeds

final turbidity value can be seen in Figure 3 for papaya seeds and Figure 4 for papaya seed powder.

From Figure 3 and Figure 4, it can be seen that the coagulant of papaya seeds with a dose of 0.3 g / L at pH 3 could remove the turbidity of Surabaya River water of 99.92% from 1,235 NTU to 7.11 NTU. While the coagulant of papaya seed powder with a dose of 0.2 g / L at pH 3 could remove the turbidity of Surabaya River water of 99.94% from the initial turbidity of 1,235 NTU to 9.82 NTU. The results of optimum pH 2 and 12 were also obtained to reduce

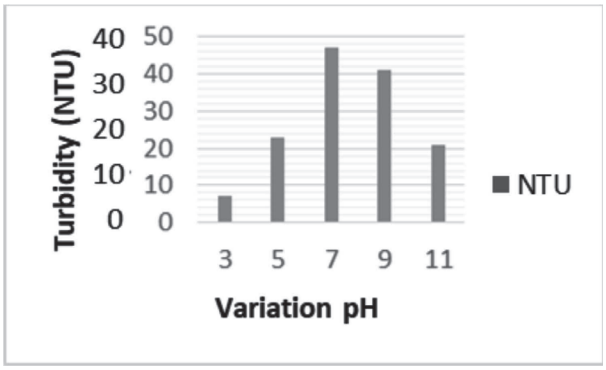

Fig. 3. Final turbidity value (NTU) for the coagulant of papaya seeds at pH variations

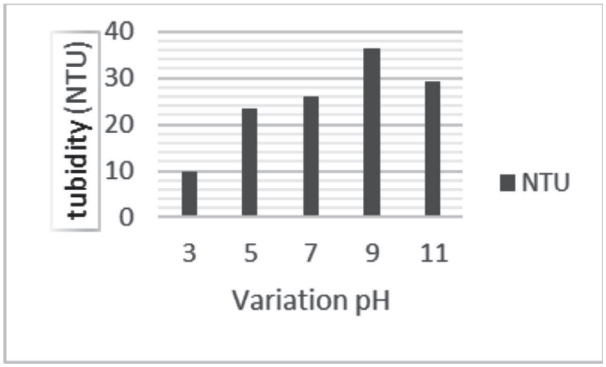

Fig. 4. Final turbidity value (NTU) for the coagulant of papaya seed powder at pH variations

turbidity with natural coagulants from Pine cone extraction (Hussain *et al.,* 2019). Based on the applicable quality standards, the final turbidity achieved in this study has met the quality standards for Sanitary Hygiene, swimming pools, Solus per Aqua, and Public Baths (Minister of Health, 2017). However, it still has not met the quality standards for drinking water (Minister of Health, 2010). This natural coagulant can be combined with PACl to meet the requirements for drinking water quality standards (Xue *et al*., 2019, Liu *et al*, 2019).

CONCLUSION

1. Coagulant of papaya seeds with a dose of 0.3 g /L at pH 3 could remove the turbidity of Surabaya River water of 99.92% from 1235 NTU to 7.11 NTU
2. The coagulant of papaya seed powder with a dose of 0.2 g/L at pH 3 could remove the turbidity of Surabaya River water of 99.94% from the initial turbidity of 1235 NTU to 9.82 NTU.

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