The potential of wheat germs as a coagulant to treat batik wastewater

Nurhaslina C.R[1],Ku Halim Ku Hamid[2], And S.Z Mohamad[3]
* Faculty of Chemical Engineering, UiTM Malaysia
nurhaslina483@salam.uitm.edu.my, kuhalim@salam.uitm.edu.my and sitizuraida7@yahoo.com

Abstract*— The purpose of this study is to identify the potential of wheat germs as a coagulant to treat batik wastewater. Dyestuffs present in textile industry wastewater are hardly to degrade by biological means and many synthetic dyes are toxic, mutagenic and carcinogenic. Dye can be removed from wastewater by chemical and physical methods such as adsorption, coagulation and flocculation, oxidation, filtration and electrochemical methods. However, coagulation is one of the most common processes in the water and wastewater treatment. An organic polymer Polyaluminium Chloride (PAC) and inorganic salt Aluminium Sulphate (Alum) are the most widely used coagulant in water treatment. In order to reduces the harmful of chemical coagulants toward environment, the naturally sources coagulants that are easily available and abundantly left without significant usage has been investigated and discovered. For this study, wheat germs will use as the natural coagulant. The newly invented plant based coagulant, wheat germs are the abundantly available agricultural in Malaysia and cheap. Besides that, wheat is categorized in cereal group which is well known as the food that has the ability to absorb cholesterol in blood. Jar Test method was used to conduct the coagulation process for dye wastewater from textiles industries. It is discovered that the wheat germ has successfully removed 66% of COD, 87% of turbidity and 86.5% of color of the dye wastewater through coagulation process. Based on this fact, wheat germs have a big potential to become as a natural coagulant to treat textiles wastewater.

***Keywords*—coagulant, wheat germs, dye wastewater**

INTRODUCTION

In Malaysia, the most famous textile industries are Batik industries which have various processes. Among them, dyeing processes uses large amount of water and the wastewater from dyeing process contains toxic wastes such as suspended solid, unreacted dyestuffs and auxiliary chemicals that are used in dying process. According to Kadolph (2007), heavy metal are introduced into the wastewater of textile manufacturing through the use of premetalized dyes and heavy metal after washes, which are used to increase the light fastness of the finished product. Besides that, according to Badani et al., (2005) textile wastewater is an important pollution source that contains high concentrations of organic and inorganic chemicals and is highly colored from the residual dyestuffs. The effluents generated contain a wide range of contaminants, such as salts, enzymes, surfactants, oxidizing and reducing agent. The common wastewater treatment technique of textiles industry effluents are biological treatment and chemical precipitation, membrane technology, activated carbon adsorption and evaporation.

Dye is an organic compound composed of a chromophore, the colored portion of the dye molecule, and an auxochrome, which slightly alters the colors. The auxochrome make the dye soluble and is a site for bonding to the fibers. Dyes are molecules that can be dissolved in water or some other carriers so that they will penetrate into the fiber, any undissolved particles of dye remain on the outside of the fiber, where they can bleed and are sensitive to surface abrasion (Kadolph, 2007).

OBJECTIVES

In this research, there are several objectives such as to determine the potential of wheat germ as coagulant and to determine the optimum quantity of coagulant to be used. Besides that, the aim is to distinguish the COD, pH value, turbidity and color of the sample water before and after treatment by adding the coagulant.

MATERIALS AND METHODS

Sample collection

The sample of dye wastewater had been collected from Faculty of Art & Design, UiTM Malaysia. The samples had been collected after the dyeing processes has finished. The collecting of the sample had been carried out following the Standard Method for the Examination of Water and Wastewater No-Collection & Preservation of Samples (APHA, 1999). The samples were put into several 1.5 L bottles and were closed tightly. The samples had been delivered to the lab for analysis as soon as possible to avoid any oxidation and contamination from others.

Initial characteristics

The initial characteristics of the dye wastewater had been analyzed as received in the lab. The Chemical Oxygen Demand (COD), turbidity and color were analyzed by using Spectrophotometer (MERCK Spectroquant NO) while the initial pH of the dye wastewater will record by using pH meter (EUTECH Instrument pH510). These data were used to differentiate and analyzed the effectiveness of the treatment.

Wheat germs preparation

Only good quality of wheat which is free from any diseases and fungi had been used in this experiment. The wheat germs had been dried and blended. In this experiment, the samples have been sieve first to get the size that needed. Retsch AS 200 has been used with basis amplitude 100 and the samples have been sieved for 20 minutes. For this experiment, the size aperture that had been used is 250 µm. Then, 800 g of wheat germ had been added with 1 liter of distilled water and had been heated until it forms a porridge form and become glutinous. After that, it will be separated by different quantity; 10 g, 15 g, 20 g, 25 g and 30 g. Then, it had been added with 1 liter distilled water and again the mixture had been heated until it boiled.

Jar test

In this research, the most important part is the Jar Test Method. For this research, floc tester (Chemix Flox-Tester) with six paddle and 500 ml beaker had been used in this experiment to get the optimum pH and dosage in coagulation process. The jar test procedures involve the following steps:

1. The jar testing apparatus containers had been filled with 5 ml of dye waste water and 500 ml of distilled water. One container will be used as a control while the other 5 containers had been adjusted and were marked with 1 to 6. Firstly, the pH of the dye had been adjusted into pH 4, 5, 6, 7, 8, and 9 respectively by using 1.0 M H_2SO_4 or 1.0 M NaOH to determine optimum operating conditions.
2. Then, 10 ml of wheat germ with concentration 20 g/l had been added to each container and was stirred at slow mixing for 1 to 3 min to allow for floc building

then proceed with rapid mixing speed approximately 120 rpm for 30 min.

3. The mixer was turn off and the containers were allowed to settle down for 30 minutes. Then the final turbidity and color in each container was measured and recorded. The final turbidity and color has been measured using a Spectrophotometer (MERCK Spectroquant NO).
4. For the second round of the experiment, the concentration of the 20 g/l of wheat germ was added into dye waste water which had an optimum pH that had been find out from the previous experiment. Now, volume of the coagulant had been adjusted into 5 ml, 10 ml, 15 ml, 20 ml, 25 ml and 30 ml and again was stirred at slow mixing for 1 to 3 min to allow for floc building then proceed with rapid mixing speed approximately 120 rpm for 30 min.
5. After that, the mixer was turn off and the containers were allowed to settle for 30 minutes and the final turbidity and color in each container was measured.
6. Then for the third round of the jar test, the concentration of the wheat germ had been adjusted into 10g/l, 15 g/l, 20 g/l, 25 g/l and 30 g/l with optimum pH of dye waste water and optimum dosage of wheat germ added that had been known from the previous experiment.
7. As previously, it was stirred at slow mixing for 1 to 3 min to allow for floc building then it was proceed with rapid mixing speed approximately 120 rpm for 30 min.
8. After that, the containers were allowed to settle for 30 minutes and the final turbidity and color in each container was measured.
9. For each experiment had been repeated for three times.
10. Lastly, after all experiments had been done, the data that had been collected will be analyzed. In this research, only COD, pH, color and also the turbidity had been analyzed.

RESULT AND DISCUSSION

Characteristics of Dye

An initial experiment was performed to determine the initial characteristics of dye concentrated effluent for monitoring the effectiveness of the coagulation and flocculation process after wastewater treatment using the wheat germs. The characteristics of raw effluent are summarized in table 1:

Table 1: Initial and Final Characterization of Dye after Treatment

Parameters	Initial Value	Final Value
pH	9.42	6
COD (mg/l)	29700	19600
Turbidity (NTU)	12,700	1650
Color (m^{-1})	2070	280

The effect of pH on coagulation process using wheat germs

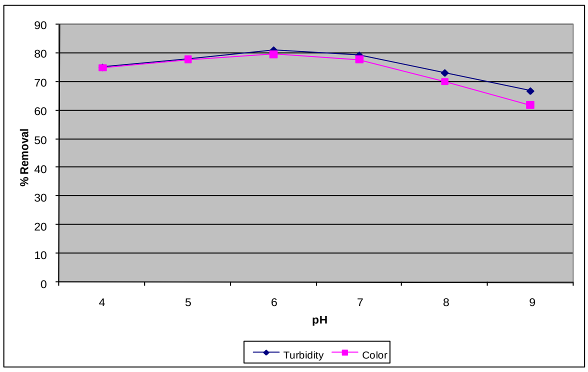

Figure 1: The effect of pH values on the removal of color and turbidity using wheat germs.

The effect of pH value on the removal of turbidity and color using wheat germ as a coagulant is shown in figure 1. The volume of dye that has been used was 5 ml and 500 ml of dilute water, while the volume of the wheat germ was 10 ml with concentration of 20 g/L. It can be clearly seen that the optimum range of pH in term of percentage removal of color and turbidity is 6. In the pH range 4-7, turbidity and color shows below 82%. The results are in agreement with those reported by Zhang et al., (2006), who showed that the use of *M.Oleifera* does not alter pH and it is not easy to confirm the optimum pH. The turbidity and color removals show a decrease at pH 7 to 9 and above which particle size of dye concentrated effluent become difficult to destabilize. This could be due to the charges of particles are neutralized by positively charged coagulants hydrolysis species in which zero point of charge (ZPC) is shifted to acidic region for raw water due to the increased charge of dissolved organic matter (Kim et al., 2001). In the present work, it is recommended that the pH value of 6 is the best in terms of turbidity and color which are found to be around 81.1% and 79.7% respectively when wheat germ's is used as a coagulant in coagulation process.

The effect of dosage on coagulation process using wheat germs

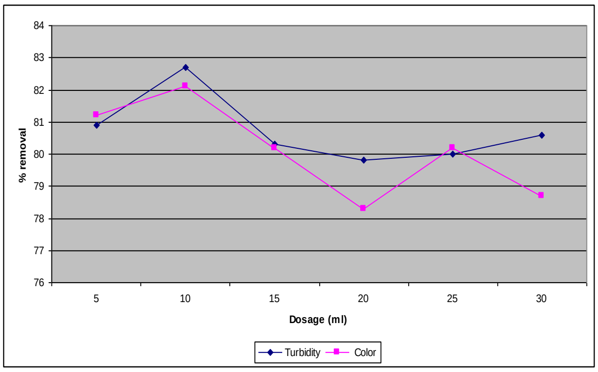

Figure 2: The effect of coagulant dosage on the removal of color and turbidity using wheat germs at pH 6.

A series of experiment had been conducted to get the optimal dosage of the wheat germ to give the best result in treating dye wastewater. In this experiment, the constant pH of 6 of dye wastewater has been adjusted. The volume of wheat germ has been varied from 5 ml to 30 ml while the volume of dye wastewater is constant at 500 ml per beaker. Figure 2 shows that the best removal of turbidity is at dosage of 10 ml that give 2200 NTU which is 82.7% removal. However, the percentage of turbidity and color shows slightly decreases when the concentration exceeds 10 ml and its shows a slightly increase at a dosage 25 ml. But, the turbidity percentage removal shows uncertainly in the dosage ranges 5 ml to 30 ml in which 79-83% removal is achieved. This can be concluded that the decrease in the turbidity removal is due to a result of re-suspension of solids at certain concentration and it depends on the pH of dye wastewater. According to previous research by Amuda et al., (2005), this may be as a result of re-suspension of solids at this concentration. The dosage of wheat germ's has been increased up to 30 ml to find out a specific trend, but the percentage of turbidity and color removal is getting inconsistent as dosage increases. Taking into consideration that by increasing the dosage will give inconsistent performance of turbidity and color removals, the dosage of 10 ml is recommended the best in terms of percentage of turbidity and color removal efficiencies which are found to be 82.7% and 82.1%, respectively, when wheat germ is used as coagulant at pH 6.

The effect of Concentration on coagulation process using wheat germs

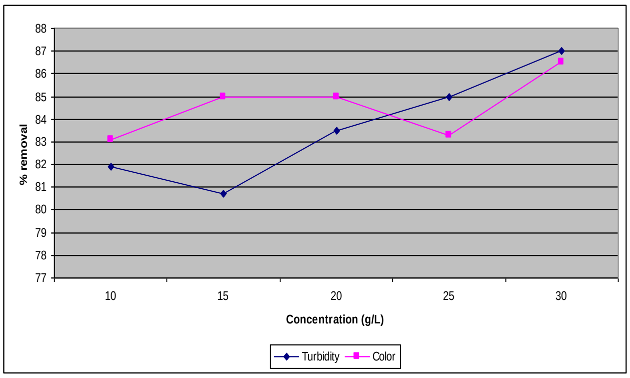

Figure 3: The effect of concentration of coagulant dosage on the removal of color and turbidity using wheat germ at pH = 6 and dosage = 10 ml

A series of experiment had been conducted to get the optimal concentration of the wheat germ to give the best result in treating dye wastewater. In this experiment, the constant pH of 6 of dye wastewater and 10 ml of wheat germ has been adjusted. The concentration of wheat germ has been varied from 5 g/L to 30 g/L while the volume of dye wastewater is constant at 500 ml per beaker. Figure 3 shows that the best removal of turbidity is at concentration of 30 g/l that give 1650 NTU which is 87% removal. There are over 80% removal of the turbidity has been recorded for all the dosages of the wheat germ. While for the color removal, concentration of 30 g/L gives the best result which is 86.5% removal. The removal of turbidity however has decreases slowly, when the concentration of wheat germ exceeds 10 g/L. According to a study by Amuda et al., (2005), this may be as a result of re-suspension of solids at this concentration. However, the removal of turbidity increase drastically after the concentration of the wheat germ is exceeds 15 g/L until 30 g/L. Thus, it is recommended that the coagulant concentration of 30 g/L is the best in term of percentage turbidity and color removal which found that 87% and 86.5% respectively when wheat germ is used as a coagulant at pH 6. As a conclusion, by comparing the result with the current study, the wheat germ has demonstrated similar performance in coagulation process and it deserves to be used as an alternative coagulants.

CONCLUSIONS

From this research, it can be concluded that;

a. The coagulation of dye wastewater with wheat germs performed the same result with commercial coagulants. The result that was obtained is successfully removed 87% turbidity removal and 86.5% color removal
b. The optimum pH for the coagulation of wheat germs was at pH 6. While for the optimum dosage for wheat germ is 10 ml. For the concentration of 30 g/L of the wheat germ was recommended to be the best in terms of percentages turbidity and color removal efficiencies which were found out to be 87% and 86.5% respectively, when wheat germ was used as a coagulant at pH 6 and the dosage at 10 ml.
c. Thus, in the future, it is estimated that the wheat germ will no longer be scarce and could easily obtained due to it abundance source.

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