Effect of Flow Rate on the Absorption of Rhodamine B, Methyl Orange and Methylene Blue Dyes with Langsat Shell (*Lansium domesticum*)

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Abstract. Dye waste comes from textile, paint, batik and food industries wastes that produces colored liquid waste which is harmful to the environment. For this reason, the research is carried out to find solutions to these problems. This study aims to determine the effect of flow rate on dye absorption using the column method. Adsorption was carried out by langsat shell activated with nitric acid. The flow rate variations used were 1 mL/minute, 2 mL/minute, 3 mL/minute and 4 mL/minute. The results obtained were that the rhodamine B dye absorbed 1.7901 mg/g, the methyl orange dye occurred 6.0827 mg/g, and the methylene blue dye 12.524 mg/g.

1. Introduction
In general, dye from textile industrial wastewater is an organic compound that has an aromatic structure so that it is difficult to degrade naturally and is certainly not environmentally friendly [12]. One method that can be used to overcome this pollution due to textile dyes is through the biosorption method because it does not require high costs, is easy to apply, and the use of environmentally friendly adsorbents derived from natural materials. Dyestuff waste will enter and be bound into the adsorbent pores, resulting in waste with smaller levels of dye contaminants than before. Some of the adsorbents that have been reported are: corn cobs [7], biomass of Chorella sp [8] and durian shell [11]. One of the environmentally friendly adsorbents which is also waste is olive skin. This material was chosen because it is easy to find in Indonesia and cheap. In the skin of langsat there are flavonoids, terpenoids and saponins compounds. In triterpenoid compounds there are lancic acid and lansiolic acid which can absorb dye in aqueous solution. Utilizing langsat peel waste (*Lansium domesticum*) as a natural biosorbent and adsorbent that already exists by activating the adsorbent for dye absorption is a good way to increase absorption efficiency. The requirements for a good adsorbent are having high effectiveness and selectivity [9]. To increase the absorption of langsat skin, an activation process is carried out using acids. Activation of this langsat shell is in order to remove impurities that cover the active site of langsat skin which can interfere with the adsorption process and cause a decrease in adsorption capacity [5,6].

There are many factors that influence physical and chemical adsorption, namely: temperature, solvent properties, and solution pH [11]. The adsorption methods that are commonly used are the
batch and column method. The chromatography method is one of the most widely used purification techniques in chemical analysis and production processes because of its selective nature. In the production process, chromatography is usually used for the refining process. Chromatographic purification is carried out by utilizing differences in general physico-chemical properties of molecular or ionic shape, particle size, solubility and others [2]. The advantage of the column method is the use of flow in the adsorption process. The column system is more advantageous because the operating system is always in contact with the adsorbent solution so that the adsorbent surface can absorb optimally until saturated conditions.

Chromatography is the process of separating solutes based on differences in the migration of a system consisting of a stationary phase and a mobile phase. One of the mobile phases that is often used is a molecule that has different mobility resulting in differences in adsorption, partition, solubility, vapor pressure, molecular size, or ionic charge density. The difference in how chromatography works provides a variety of techniques such as ion exchange chromatography, size exclusion chromatography, normal phase chromatography, reverse phase chromatography, affinity chromatography [3]. In the separation process, several compounds will come out of the column at different times, because the whole process is a migration generated by selective driving forces from the mobile phase. One of the processes of containment and release of chemical compounds in the chromatography process is due to the shape and structure of the packed column or packed resin. The column packaging process will affect the column efficiency. One of the influencing parameters is the flow rate. Where the linear flow rate value of a resin has an interval limit from the column height used [4]. Based on the description above, a study was carried out on the adsorption capacity of langsat (Lansium domesticum) peel against dyes using the column method by varying the flow rate which affected the adsorption. This study aims to determine the adsorption capacity of langsat peel against Rhodamine B, Methyl Orange and Methylene Blue. So the optimal flow rate test is needed to produce a good column packing [1] by optimizing the pH of the solution, the concentration of the solution and the mass of the optimum adsorbent.

2. Materials and Methods

2.1. Reagent and Chemicals
Glassware, shaker (model: VRN-480), pH meter (HI2211), analytical balance (ABS 220-4), filter paper, magnetic stirrer (MR Hei Standard), oven, spray bottle, sifter (BS410). The instrument used was Spectronic Genesys 20 Visible. The ingredients used in this study were langsat shell, aquades, 1000 mg/L Rhodamin B, Methyl Orange and Methylene Blue Solution, NaOH 0.1 M, HNO₃ 0.01 M, HNO₃ 0.1 M, HNO₃ 1 M, HNO₃ 0.5 M, HNO₃ 5 M.

2.2. Sample Preparation
Langsat shell from the main market in the city of Padang. Langsat cleaned and destroyed using a grinding machine, mashed with mortar and pestle, and then sifted to a size of 150 [5]

2.3. Preparation of Column
The column was prepared by weighing 0.2 grams of langsat shell with cotton at the bottom of the column. The column consists of a set of infusion equipment with the tap (flow rate regulator) set to a fixed position. The eluent that comes out is collected using a vial bottle. Variations in the flow rate used were 1 mL/minute, 2 mL/minute, 3 mL/minute and 4 mL/minute

3. Result and Discussion

3.1. Effect of flow rate of rhodamine B dye on langsat shell
The column method is used by flowing the sample from the sample tube into the column. The sample flow was adjusted in the infusion setting, the infusion flow was adjusted according to the adsorbate
flow rate used, namely 1, 2, 3 and 4 mL/minute. Rhodamine B dye is a solute or adsorbate which has an initial concentration. The solution is then flowed through the adsorbent column from top to bottom. The top of the adsorbent that comes in contact with the high concentration of the adsorbate mixture for the first time will very quickly absorb the rhodamine B dye and the adsorbate that passes will be absorbed by the next part. The filtrate from this column can be said to be adsorbate free with the final concentration. The results of this filtrate will be tested in Spektronik Genesys 20 seen, it can be seen from the effect of changes in flow rate on absorption of rhodamine B which can be seen in Figure 1.

![Figure 1. Effect of flow rate on the adsorption capacity of rhodamin B using langsat shell (pH 3, 10 mL of rhodamin B solution 100 mg/L, 0.2 grams massa biosorbent)](image)

In Figure 1, it can be seen that the absorption capacity has increased at 2 mL with a capacity of 4.4753 mg/g. This is because the rhodamine B dye that enters the sample binds faster. The adsorption time needed to reach a saturated state decreases with increasing flow rate. The flow rate also shows how long the adsorbent contact with the adsorbate. The faster the flow rate means the faster the bonding time between the adsorbent and the adsorbate. At the highest flow rate, rhodamine B flows faster so that the bonds with the sample are easily released and have little absorption capacity. The optimum flow rate is determined from the value of the largest absorption capacity. From these data it can be concluded that the flow rate of 2 mL/minute has the greatest adsorption capacity.

3.2. Effect of flow rate of Methyl Orange dye on langsat shell

In this study, the flow rate variations were the same but the pH, solution concentration and mass of biosorbent were different. The pH used was 4 and a methyl orange dye solution with a concentration of 150 mg/L and a mass of 0.2 grams of biosorbent. The top layer of the adsorbent is the layer where there is direct contact between the adsorbent surface and the initial concentration solution, while the adsorbent layer underneath will absorb the solution with a lower concentration, and so on. However, over time, the adsorbent will reach a saturated state, which is a condition where the adsorbent cannot adsorb due to reduced absorption efficiency. The results of the absorption of the methyl orange dye can be seen in Figure 2.
Figure 2. Effect of flow rate on the adsorption capacity of methyl orange using langsat shell (pH 4, 10 mL of methyl orange solution 150 mg/L, 0.2 gram massa biosorbent)

Figure 2 shows that the optimum absorption occurs at 3 mL/minute with an adsorption capacity of 6.0827 mg/g. At a flow rate of 1 mL/minute to 3 mL/minute there is an increase in absorption capacity due to the slow flow rate, if the flow rate flows quickly, the bond between the biosorbent and the dye will also release more quickly.

3.3. Effect of flow rate of Methylene Blue dye on langsat shell
Methylene blue is a major concern in the waste treatment process because its color is difficult to degrade. These compounds are toxic, cause genetic mutations, and affect reproduction. This study used a pH of 6, a concentration of 350 mg/L and a mass of biosorbent 0.1 gram. The results of absorption on methylene blue can be seen in Figure 3.

Figure 3. Effect of flow rate on the adsorption capacity of methylene blue using langsat shell (pH 6, 10 mL of methylene blue solution 350 mg/L, 0.1 grams massa biosorbent)
Figure 3. shows that the optimum absorption results occur at 2 mL/minute with an absorption capacity of 12.524 mg/g. The adsorption capacity increases at 2 mL/minute and decreases at 3 mL/minute. This is due to the fact that an increase in flow rate can affect the absorption capacity, a faster flow rate can cause the bonds with bisorbent to break easily and their absorption capacity

4. Conclusion
Langsat shell (Lansium domesticum) which is agricultural waste can be used as an adsorbent to absorb various dyes. The optimum absorption capacity of 4.4753 mg/g in rhodamine B dyes with a flow rate of 2 mL/minutes, in methyl orange dye a capacity of 6.0827 mg/g with a flow rate of 3 mL/minute, and the methylene blue dye with a capacity of 12.524 mg/g with a 2 mL/minute.

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