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# Effect of Particle Size and Stirring Speed on Rhodamine B Absorption Using Langsat Shell *(Lansium domesticum)* as Biosorbent

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## Abstract:

Waste from factories in the textile, batik and food industries needs to be addressed to remove pollutants from dyes and heavy metals from liquid waste as the focus of this research. Biosorption is an alternative method to reduce the presence of dyes in solution by using biomaterials which are often called biosorbents. Langsat skin used as a biosorbent has been shown to bind dyes ions in the presence of active groups such as: amines, hydroxyl, carbonyl and carboxyl which can form complexes with dye ions. This study used a batch method with variations in particle size and stirring speed with pH 2 and rhodamine B concentration of 100 mg/L. The results of each variation conducted obtained the optimum conditions for the absorption of rhodamine B dyes, particle size of 150 µm and stirring speed of 150 rpm.

*Keywords* **—Biosorption, rhodamine b, langsat shell, batch method**

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## I. INTRODUCTION

Dyes in the textile industry have developed from year to year [1]. However, most textile industries use synthetic dyes for reasons of cheap, durable, easily obtained and easy to use, but the resulting waste contains synthetic dyes and is also difficult to degrade. The textile waste contains dyes of organic compounds from the type of prosion, erionil, auramine and Rhodamin B. The dyes that are often used in the textile industry such as paper mills are rhodamine b is a basic dye (cation) which is generally a chloride or oxalate salts from organic bases [2]. The use of rhodamin B in industry will cause these compounds to be found in industrial wastewater. Industrial wastewater without further management is then channeled into rivers that will be utilized by the community for daily use [3]. This will have many fatal impacts on people's lives, especially in the health sector [4]. Examples of dyes that are often used are rhodamin B, methylene blue, methyl orange and methyl violet [5].

Rhodamin B is a chemical that is used as a basic coloring agent in textiles and paper. This coloring agent has several other names, namely: Tetra ethyl rhodamine, Rheoninine B, D & C Red No. 19, C.I. Basic Violet 10, C.I. No 45179, Food Red 15, ADC Rhodamine B, Aizen Rhodamine and Brilliant Pink B. While the chemical name is N- [9- (Carboxyphenyl) -6- (diethylamino) -3H-xanten-3-ylidene] -N-ethylethanaminium chloride by molecular formula:

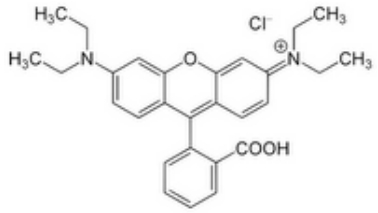


Fig 1. Structure Rhodamine B

  

Synthetic dyes are generally derived from azo compounds and their derivatives from benzene groups [6]. The benzene group is very difficult to degrade and requires a long time [1]. To overcome this, it is necessary to use this biosorption method using langsat skin as biosoben. Biosorbent is a solid substance that can be used to absorb certain components of a fluid phase. Biosorbent is very widely used on an industrial scale as a purification or separation of gases or liquids and also as a supporting catalyst [7]. Some of the adsorbents that have been reported are: Bagasse [8], rice husks [9] and durian shells [10].

Langsat *(Lansium domesticum)* have variety triterpenoid compounds, flavonoids, and saponins. Inside the triterpenoid compound there are landsic acid and lansiolic acid. These compounds which can absorb dyes in aqueous solution. Functional groups contained in the components of these compounds such as: N-H, O-H, C=O and COOH [11].

## II. METHODS

### A. *Reagents and chemicals*

Glassware, shaker (model: VRN-480), pH meter (HI2211), analytical balance (ABS 220-4), filter paper, magnetic stirer (MR Hei Standard), oven, spray bottle, sifter (BS410 ). The instrument used was FTIR (Fourier Transform Infra Red) perkin elmer universal type ATL Sampling Accessor 735 B and 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, $HNO_3$ 0,01 M, $HNO_3$ 0,1 M, $HNO_3$ 1 M, $HNO_3$ 0,5 M, $HNO_3$ 5 M.

### B. *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 [12].

### C. *Activation of Langsat Shell Biosorbent*

A total of 20 grams of langsat peel was activated with $HNO_3$ 0,01 M. For 2 hours, then washed with distilled water until neutral, then dried and dried [12].

### D. *Dyestuff Biosorption Experiments*

Biosorption of dyes in the langsat shell was applied in a flask containing 25 mL and biosorbent was stirred at 150 rpm, mass 0.2 g and particle size 150 µm. We studied the effects of pH (4) and initial dye concentration (100 mg/L) with particle size variations of 150, 180, 250, 355 and 425 µm and stirring variations of 100, 150, 200, 250 and 300 rpm. Filtrate is measured electronically. For the adsorption potential of heavy metal ions, the following equation is calculated:

$$Q = \frac{Co - Cf}{M} x\ V$$

Where,
Q = the uptake capacity (mg/g)
Co = the initial metal concentrations (mg/L)
Cf = the final concentrations of metal ions (mg/L)
M = the adsorbent mass (g)
V = volume of solution (L) [13].

The efficiency of adsorption of heavy metal ions is calculated in the following equation:

$$E = \frac{Co - Cf}{Co} X\ 100\ \%$$

Where,
E = absorption efficiency (%)
Co = the initial metal concentrations (mg/L)
Cf = the final concentrations of metal ions (mg / L)

## III. RESULT AND DISCUSSION

### A. *Effect of particle size on the absorption of rhodamine B dyes using langsat shell*

Particle size also affects absorption ability. The smaller the size of the biosorbent used, the

  

more surface area. If the size of the biosorbent used is larger it can cause a decrease in the surface area of the biosorbent. And larger particle size can increase internal diffusion of biosorbent penetration thereby inhibiting equilibrium and consequently reducing absorption ability. The difference in absorption capacity and absorption efficiency to particle size variation can be seen in Figure 2.

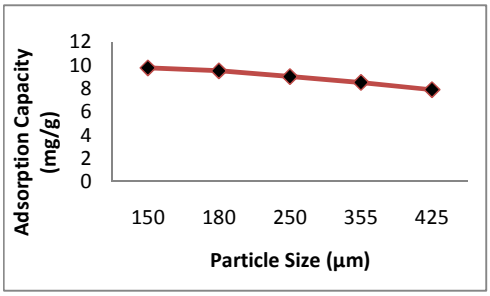


Fig.. 2 Effect of particle size on absorption capacity of rhodamine B using langsat shell

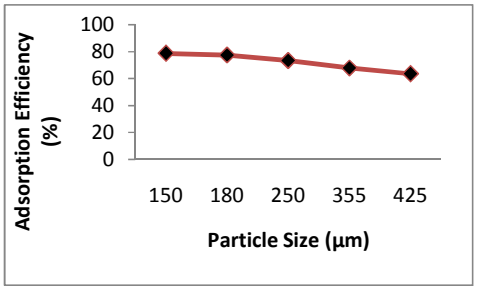


Fig.. 3 Effect of particle size on absorption efficiency of rhodamine B using langsat shell

In Fig. 2 shows the absorption capacity of rhodamine b increases up to a maximum adsorption at 150 µm with an absorption capacity of 9.75 mg/g, there is a decrease in capacity at a larger particle size. The reduction occurred from a particle size of 150 µm to 425 µm.

In fig. 3 the efficiency absorption of rhodamine B dyes by particle size is related to surface area. The smaller the particle size, the greater the surface area and the more interactions on the particle surface with hydroxyl, amino, ester, carboxyl and ether functional groups, resulting in increased absorption efficiency [14]. From Fig. 5 it can be seen that the absorption efficiency decreases with increasing biosorbent particle size. Therefore, the smaller the particle size, the greater the absorption that will occur, because the ions will penetrate into the pores in the particles [15][16].

### B. *Effect of stirring speed on the absorption of rhodamine B dyes using langsat shell*

In the adsorption process, the stirring speed is used so that the adsorbent with the adsorbate interacts perfectly. The stirring speed greatly effect the biosorption results of the rhodamine B dye ion. This is because the faster the stirring, the contact that occurs between the active site on the surface of the biosorbent with metal ions will be faster and better, resulting in a large absorption capacity. But mixing with high speed will make the adsorbate released which has been bound [17]. The effect of stirring speed variations on the absorption of rhodamine B dyes are 100, 150, 200, 250 and 300 rpm.

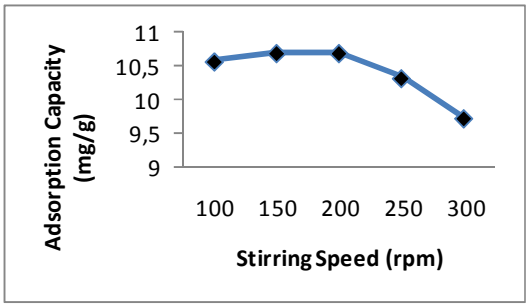


Fig. 4 Effect of stirring speed on absorption capacity of rhodamine B using langsat shell

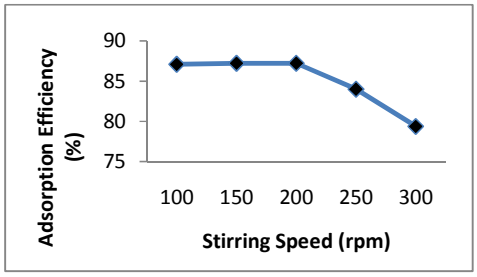


Fig. 5 Effect of stirring speed on adsorption efficiency of rhodamine B using langsat shell

  

In fig. 4 show the uptake maximum stirring speed occurs at a speed of 150 rpm with an absorption capacity of 10.68 mg/g. Increasing the stirring speed can increase the absorption capacity. Furthermore, there is a decrease in absorption capacity after 150 rpm, this occurs because the biosorbent has been saturated and can not absorb rhodamine B dye ions.

In fig. 5 the absorption efficiency shows a decreased efficiency in accordance with its absorption capacity. This is because the higher the absorption capacity, the higher the absorption efficiency. In theory, the higher the stirring speed will produce greater efficiency because the stirring makes the adsorbent evenly distributed.

## IV. CONCLUSIONS

Based on the research that has been done, the following conclusions are obtained:

1) Langsat shell *(Lansium domesticum)* which is agricultural waste can be used as an adsorbent to absorb rhodamine B.

2) Adsorption capacity reaches 9.75 mg/g in particle size variations and at stirring speed variations of 10.68 mg/g

3) The efficiency of absorption in the variation of particle size reaches 78.79% and at the stirring speed reaches 87.24%

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## REFERENCES

[1] Mamoto,L.V.; Citraningtyas,F.G.: 2013. *Analisis Rhodamin B pada Lipstik yang Beredar di Pasar Kota Manado*. Jurnal Ilmiah Farmasi-UNSRAT. Vol 2, No 2,61-66.

[2] Sahara E., Gayatri P.S., dan Suarya P. 2018. *Adsorpsi Zat Warna Rhodamin B Dalam Larutan Oleh Arang Aktif Batang Tanaman Gumitir Teraktivasi Asam Fosfat.* Jurusan Kimia FMIPA Udayana, Bali.Ferreira, B.C.S., Teodoro, F.S., Mageste, A.B., Gil, L.F.,

[3] Yasim, N.S.M., Ismail, Z.S., Zaki, S.M., and Azis, M.F.A. 2016. *Adsorption of Cu, As, Pb and Zn by Banana Trunk*. Malaysian J. Anal. Sci. 20(1):187-196.

[4] Katsou, E., S. Malamis, and K. Haralambous. 2010. Examination of zinc uptake in a combined system using sludge, minerals and ultrafiltration membranes. J. Hazard. Mater. 182(1–3): 27–38. doi:10.1016/j.jhazmat.2010.05.101

[5] Irawati, H., Hidayat, A, N., dan Sugiharto, E. 2018. *Adsorpsi Zat Warna Kristal Violet Menggunakan Limbah Kulit Singkong (Manihot esculenta).*

[6] Pertiwi D,Sirajuddin S, NajamuddinU. 2013. *Analisis kandungan zatpewarna sintetik rhodamin B dan methanyl yellow pada jajanan anak di SDN kompleks Mangkura Kota Makassar*. Repository Unhas. pp: 1-14.

[7] Ibrahim, W.M. 2011. *Biosorption of Heavy Metal Ions From Aqueous Solution by Red Macroalgae.* J. Hazard. Mater. 192: 1827-1835

[8] Ferreira, B.C.S., Teodoro, F.S., Mageste, A.B., Gil, L.F., Freitas, P., and Gurgel, L.V.A., 2015. *Application of A New Carboxylate-Functionalized Sugarcane Bagasse for Adsorptive Removal Of Crystal Violet from Aqueous Solution*: Kinetic, Equilibrium andThermodynamic Studies, Ind. Crop. Prod., 65, 521–534.

[9] Masoumi, A., Hemmati, K., and Ghaemy, M., 2016, *Low-Cost Nanoparticles Sorbent from Modified Rice Husk and A Copolymer for Efficient Removal of Pb(II) and Crystal Violet from Water,* Chemosphere, 146, 253-262.

[10] Tanasale, Matheis F.J.D.P., Sutapa W., dan Topurtawy R.R. 2014. *Adsorpsi Zat Warna Rhodamin B Oleh Karbon Aktif Dari Kulit Durian (Durio zibethinus).* Jurusan Kimia Universitas Pattimura, Ambon.

[11] Munawaroh, I., 2012, *Pemanfaatan Bonggol Jagung sebagai Adsorben Rhodamin B dan Metanil Yellow*, Skripsi, Fakultas Sains dan Teknologi, UIN Sunan Kalijaga, Yogyakarta.

[12] Kurniawati, D., Lestari, I., Sy, S., Harmiwati, Aziz, H., Chaidir, Z., and Zein, R. 2016. *Removal of Cu(II) from Aqueous Solutions using Shell and Seed of Kelengkeng Fruits (Euphoria Longan Lour).* Der Pharma Chem. 8:14, 149–154.

[13] Kurniawati, D., Lestari, I., Harmiwati, Sy, S., Chaidir, Z., Zein, R., Aziz, H., and Zainul, R. 2015. *Biosorption of Pb (II) from Aqueous Solutions using Column Method by Lengkeng (Euphoria logan lou) Seed and Shell*. J. Chem. Pharm. 7:12, 872–877.

[14] Yu, W.H., Li, N., Tong, D.S., Zhou, C.H., Lin, C.X., dan Xu C.Y. 2013. *Adsorption of proteins and nucleic acids on clay minerals and their interactions*: A review. *Applied Clay Science* 80–81 (2013) 443–452.

[15] Al Othman Z. A.,A. Hashem, M. A. Habila. 2011. *Kinetic, Equilibrium and Thermodynamic Studies of Cadmium (II) Adsorption by Modified Agricultural Wastes. Molecules.* 16: 10443-10456

[16] Vankar P. S., R. Sarswat, R. Sahu. 2012. *Biosorption of Zinc Ions from Aqueous Solutions onto Natural Dye Waste of Hibiscus rosa sinensis: Thermodynamic and Kinetic Studies. Environmental Progress & Sustainable Energy.* 31, No.1

[17] Lopes, T.J., Gonçalves, O.H., Quadri, M.G.N, Machado, R.A.F., dan Quadri, M.B. 2014. *Adsorption of anthocyanins using clay–polyethylene nanocomposite particles*. *Applied Clay Science* 87 (2014) 298– 302

  