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UTILIZAÇÃO DE SEMENTES DE *Salacca zalacca* COMO ADSORBENTES DE CROMO(VI)

UTILIZATION OF *Salacca zalacca* SEEDS AS CHROMIUM(VI) ADSORBENTS

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RESUMO

O sistema de tratamento de resíduos de cromo(VI) nas atividades da indústria têxtil na Indonésia é um problema ambiental que realmente precisa de atenção. Isso ocorre porque o cromo(VI) é um metal pesado que se enquadra na categoria de materiais perigosos e tóxicos. Para que possa ter um impacto negativo no meio ambiente e na saúde do corpo. Um simples esforço de processamento para reduzir a quantidade de cromo (VI) nos resíduos é o método de biossorção usando adsorventes orgânicos. Um desses adsorventes orgânicos são as sementes de Salacca zalacca. As sementes de Salacca zalacca podem ser usadas como um adsorvente alternativo porque possuem fibras de celulose que podem adsorver íons de cromo(VI) nos resíduos. Esta pesquisa foi realizada com uma amostra de resíduos de corantes de roupas obtidos em uma das escolas de engenharia têxtil de Bandung, na Indonésia. Além disso, também foram realizadas pesquisas sobre a determinação da dosagem correta, para que os resultados de adsorção fossem máximos. Os resultados mostraram que o pó de sementes de Salacca zalacca foi capaz de absorver até 76,21% da quantidade de cromo(VI) em 100 mL de amostras de resíduos com uma dose de 4 gramas. Estes resultados indicam o nível de eficácia e boa absorção de sementes de Salacca zalacca em pó. Para que este método possa ser usado como um método alternativo para tratar os resíduos de cromo(VI) de uma maneira mais simples e barata.

Palavras-chave: Biossorção, Crómio (VI), Tratamento de resíduos, Águas residuais.

ABSTRACT

The Chromium(VI) waste treatment system in the textile industry activities in Indonesia is an environmental problem that really needs attention. This is because Chromium(VI) is a heavy metal that falls into the category of hazardous and toxic materials. So that it can have a negative impact on the environment and health of the body. One simple processing effort to reduce the amount of Chromium(VI) in waste is the biosorption method using organic adsorbents. One of these organic adsorbents is *Salacca zalacca* seeds. *Salacca zalacca* seeds can be used as an alternative adsorbent because they have cellulose fibers that can adsorb Chromium(VI) ions in waste. This research was conducted using a sample of clothing coloring waste obtained from one of the textile engineering schools in Bandung, Indonesia. In addition, research was also conducted on determining the right dosage so that the adsorption results were maximal. The results showed that *Salacca zalacca* seed powder was able to adsorb as much as 76.21% of the amount of Chromium(VI) in 100 mL of waste samples with a dose of 4 grams. These results indicate the level of effectiveness and proper absorption of powdered *Salacca zalacca* seeds. So that this method can be used as an alternative method to treat Chromium(VI) waste in a simpler and cheaper way.

Keywords: Biosorption, Chromium(VI), Waste treatment, Wastewater.

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1. INTRODUCTION

In Indonesia, the growth of the textile industries has grown very rapidly. The development of these textile industries can cause an increased risk of environmental pollution by the waste produced. Waste is a leftover from the activity of organisms, one of which originates from industrial activities. There are three types of waste that are usually produced by human activities, namely solid waste, liquid waste, and gas waste. The type of waste produced will depend on the type of activity carried out. To reduce the impact caused by the resulting waste, it is necessary to do the right treatment. However, the high cost of waste management is an obstacle to industrial activity. So that middle and lower level industries prefer to dispose of waste directly into the environment without being treated. This phenomenon causes a very alarming environmental pollution, such as rivers, seas, lakes, and so on. Data compiled by CNBC Indonesia states that nearly 349,000 tons of liquid waste enter the river flow every day from 1900 factories around the Citarum River, Indonesia. In addition, household waste and other wastes also enter the river body. However, despite these conditions, the Citarum river remains a source of water for the surrounding community. This condition is hazardous because the community can be infected with various diseases.

In industrial activities, waste generally will contain substances or contaminants that are produced from the rest of the raw materials, solvents or additives, failed products, washing equipment, and so on. In addition, the waste can also contain heavy metal ions (Pb, Hg, Cr, and so on) which are very dangerous because they are toxic (Abdi and Kazemi, 2015; Loukidou, Zouboulis, Karapantsios, and Matis, 2004; Lichtfouse and Schwarzbauer, 2012; Kiziloz, 2019; Ordouee and Hazheminezhad, 2019). Heavy metals are a group of metals weighing more than 5 g/cm^3 (Olukanni, Agunwamba, and Ugwu, 2014). This group of metals has no biological function in plants and cannot decompose in the soil (Rodríguez, Cárdenas-González, Juárez, Pérez, Zarate, and Castillo, 2018). Some examples of industrial activities that have the potential to produce heavy metal waste are clothing, refineries, fertilizers and pesticides, metallurgy, iron and steel, leather-working, photography, electric appliance manufacturing, metal surface treating, and wastewater treatment plants (Olukanni, Agunwamba, Ugwu, 2014; Rodríguez, Cárdenas-González, Juárez, Pérez, Zarate, Castillo, 2018; Acar and Malkoc, 2004; Ordouee and Hazheminezhad, 2019).

The textile industry is one sector that has a large share in producing Chromium (Cr) waste. The Indonesian Ministry of Health states that industrial waste produced is usually in the form of liquid waste containing Cr(III) and Cr(VI) ions. Cr(III) ion is the most stable form and important component for humans and animals as a glucose tolerance factor (GTF) in insulin, lipid, and protein metabolism. But Cr(VI) ion has very high toxicity because it has an affinity for red blood cells (Nagaraj, Aradhana, Svivakumar, Shrestha, and Gowda, 2009; Hua, Chan, Wu, and Wu, 2009). Cr(VI) ion is one of the ions that are nephrotoxic and carcinogenic (Abdi and Kazemi, 2015; Gautam, Mudhoo, Lofrano, and Chattopadhyaya, 2014). Even by its nature which has a high solubility in the water, it is possible to be adsorbed into the well water of residents living near the river so that it can be consumed by humans and cause interference with the health of the body. The toxic effects that can be caused by these ions are gastrointestinal bleeding, liver necrosis, renal tubular necrosis, allergic reactions, loss of breath, shortness of breath, headache, coughing, pulmonary congestion, sneezing, kidney damage, conjunctivitis, eyes burning, corneal damage until blindness, ulcers, in-infection of the respiratory tract, tooth discoloration, and cancer (Palar, 2012). Chromium that enters the body will undergo physiological and metabolic processes. Chromium metal or chromium compounds will interact with various biological elements contained in the body so that it can cause disruption of certain functions that work in the body's metabolism (Sharov, Plotnikova, Evseev, Rykova, 2019). In the process of metabolism, Cr(VI) ions will block or inhibit the work of the benzopyrene hydroxylase enzyme (Palar, 2012). Barriers to the performance of these enzymes can result in changes in cell growth, so cells grow wild and uncontrolled. These cells are called cancer. Based on its highly toxic nature, an appropriate treatment system is needed, so that it can minimize the level of environmental pollution and consumption risks.

Various methods of processing heavy metal waste have been carried out, such as chemical precipitation, solvent extraction, ion exchange, cementation and reverse osmosis, but usually require expensive costs and not environmentally friendly (Olukanni, Agunwamba, Ugwu, 2014; Acar and Malkoc, 2004; Kocasoy and Guvener, 2009; Ordouee and Hazheminezhad, 2019). One method of

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processing waste that can be done economically and simply is the biosorption method (Ordouee and Hazheminezhad, 2019). Adsorption or biosorption is considered more economical, high efficiency, simplicity of design, and selectivity (Ordouee and Hazheminezhad, 2019). Biosorption is a process for removing heavy metals through a passive binding process in a solution so that it does not involve metabolic processes (Kocasoy and Guvener, 2009). Organic adsorbents can be used in this method. The use of microorganisms as adsorbents has been widely used, for example, such as *Aeromonas ceviae* (Loukidou, Zouboulis, Karapantsios, and Matis, 2004), *Pseudomonas aeruginosa* (Olukanni, Agunwamba, Ugwu, 2014), *Fagus orientalis* L. (Acar and Malkoc, 2004), and so on. In addition, the use of other adsorbents such as peanut husk (Abdelfattah, Ismail, Al Sayed, Almedolab, and Aboelghait, 2016) can also be done. The other potential adsorbents are *Salacca zalacca* seeds. The availability of *Salacca zalacca* seeds is very abundant because it is usually not used by *Salacca zalacca* fruit processors. In *Salacca zalacca* seeds it contains cellulose which can adsorb metal ions quite well.

Cellulose compounds consist of active groups that are charged so that they can adsorb metal ions, such as Cr(VI) ions. This is because Cr(VI) has an empty orbital that can be filled by electrons from the active compound on cellulose (Ordouee and Hazheminezhad, 2019). Thus a bond can be formed between Cr(VI) with the active compound. Several factors can affect the adsorption process, namely interaction time, the surface area of adsorbent, the molecular size of adsorbate, pH of the solution, and concentration of heavy metals. Adequacy of interaction time can maximize the adsorption process. To streamline the interaction time, the stirring process is usually carried out first. With the stirring process, the adsorbent will increasingly spread and can enlarge the contact zone with the Cr(VI) ion. The pH value of the solution will affect the type of chemical interactions that occur in the adsorption process between metal ions and the surface of the biomass. Each metal has its own pH value that allows it to be adsorbed strongly. Concentration is related to the degree of saturation of the solution. If the saturation of the solution has been reached, the ability of the adsorbent to absorb will decrease due to the limited surface capacity of the adsorbent. These five factors must be considered to be able to maximize the adsorption process.

2. MATERIALS AND METHODS

2.1. Making Salacca zalacca Seed Adsorbents

Making *Salacca zalacca* seeds adsorbent is done through the process of destruction and washing (Widhianingrum, Inawati, Usakinah, Andriyati, and Nugraheni, 2016). At the stage of destruction, *Salacca zalacca* seeds are washed and dried, then smoothed using a blender. The Salacca zalacca powder produced is filtered using a sieve so that its size is relatively the same. Furthermore, the seed powder was washed using ethanol 99% and distilled water several times. The *Salacca zalacca* powder that has been washed is then dried using an oven.

2.2. Waste Water Sample Preparation

Wastewater samples were obtained from the College of Textile Technology in Bandung, Indonesia. The sample is waste from the process of coloring clothes and contains Chromium. In order for the sample to remain stable and last long, a solution of nitric acid (HNO_3) was added as a preservative.

2.3. Making Stock Solution

The sample is filtered using filter paper to separate the residue. As much as 100 mL of filtrate is taken and put in a 1000 mL volumetric flask to be diluted. This solution labeled **Solution I**. Then 80 mL of H_2SO_4 2 M and 20 mL of Difenylcarbazide were added. The addition of diphenyl carbazide aims to maximize the absorption of waves where Cr ions will bind to form complex compounds with these molecules. Add distilled water to the limit mark on the measuring flask and let it sit for 30 minutes. At this stage, the condition of the solution must be maintained at pH 3.

2.4. Making Standard Curve

Standard curves are created to obtain straight-line equations based on plot data between absorbance and concentration of standard solutions. The equation of the line can be used to determine Cr (VI) levels that are not known after adsorbed (Andrea, 2015). Making a standard curve is done by making a standard solution of $K_2Cr_2O_7$ 0.3 ppm; 0.6 ppm; 0.9 ppm; 1.2 ppm and 1.5 ppm in a 10 mL volumetric flask. Then 2 mL of H_2SO_4 2M solution and 0.5 mL diphenyl carbazide were added. All of these standard solutions measured the adsorbance value using a UV-Vis spectrophotometer with a wavelength of 540 nm.

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2.5. Measurement of Cr(VI) Ion Concentration

2.5.1. Measurement of Cr(VI) Ion Concentration Before Adsorption

Measuring the concentration of Cr(VI) ions before adsorption was carried out by taking *Solution I. The Solution I* was centrifuged for 15 minutes, and then the obtained supernatant was inserted into the cuvette. The adsorbance measurements were carried out using a UV-Vis spectrophotometer at a wavelength of 540 nm (Minarsih, 2009; Andini, 2017). Measurements were taken twice so that the results were accurate. The calculation of solution concentration is done by using mathematical equations on a standard curve.

2.5.2. Measurement of Cr(VI) Ion Concentration After Adsorption

The Solution I was divided into five beakers with a volume of 100 mL each. In the five beakers, each of them was added with Salacca zalacca seed powder with 1 gram, 2 gram, 3 gram, 4 gram, and 5 gram. Then, the sample was stirred at a speed of 300 rpm with stirring time for 20 minutes. After that, the sample is left to stand for 15 minutes, then filtered using filter paper. The resulting filtrate was centrifuged for 15 minutes. Measuring the concentration of Cr(VI) is done by taking the supernatant and entering it into the cuvette. This procedure is done twice to obtain more accurate data.

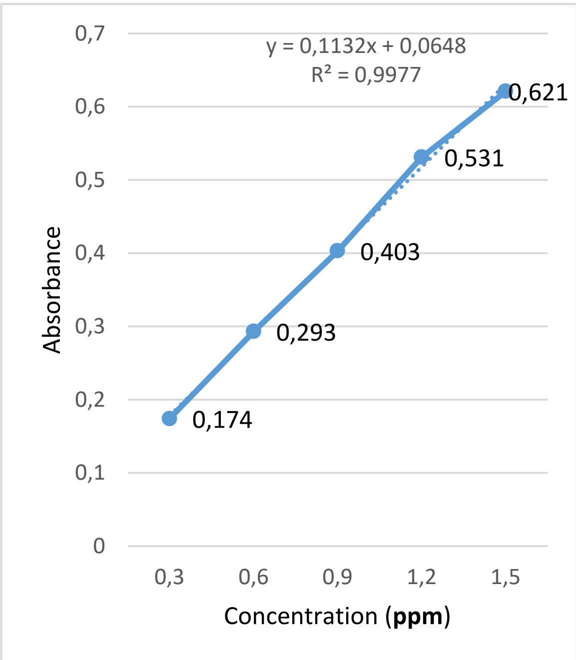

Figure 1. *Chromium(VI) Standard Curve At Wavelengths of 540 nm.*

3. RESULTS AND DISCUSSION

3.1 Standard Curve $K_2Cr_2O_7$ Solution

The standard curve is obtained by measuring the standard solution of $K_2Cr_2O_7$. The value of R in **Figure 1** shows a strong correlation coefficient because the value of R is 0,997 (approaches the value of 1). This shows that the calibration curve produces lines that are linear and the errors that occur are smaller. The line equation y = 0.1132x + 0.0648 is a straight-line equation that can be used to measure the concentration of Cr(VI) in the sample. The standard curve method is used in this study because the spectrophotometer is standardized before it is used for the sample measurement process. This certainly will affect the measurement results because each tool has different conditions. If the resulting curve does not show a linear straight-line equation, then it is necessary to check the condition of the device or possibly check the reagents used.

In the line equation in **Figure 1**, variable y is the adsorbance value, and variable x is the value of the Cr(VI) concentration. So in this case, we must calculate the value of variable x to obtain the value of the concentration of Cr(VI) ions (the calculation results are presented in **Table 3**).

3.2. Salacca zalacca Seed Adsorption Ability Against Cr(VI) Ions

3.2.1. The Concentration of Cr(VI) Ions Before Adsorption

The adsorbance value obtained through three measurements is 0.630; 0,618; and 0.616. Measurements made three times repetition aimed to obtain more accurate data on the spectrophotometer. The three data values are calculated so that the average adsorbance value of 0.620 is obtained. This value is entered into the line equation in **Figure 1**, the value of the concentration of Cr(VI) is 4.92 ppm.

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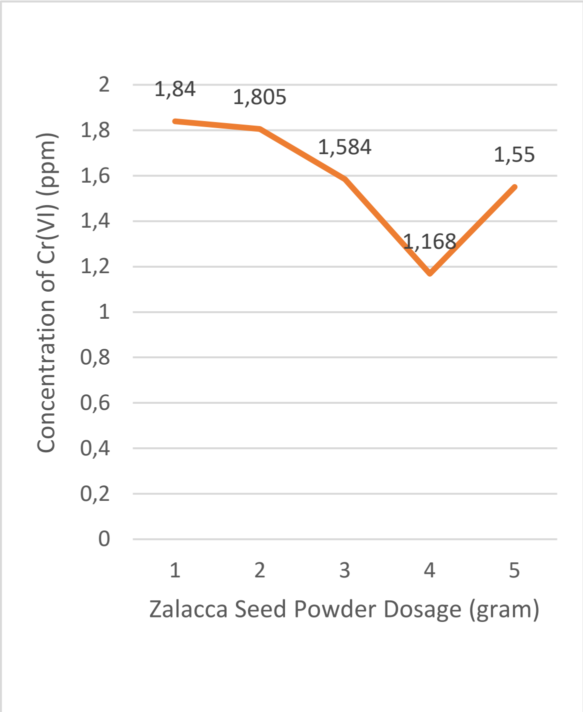

Figure 2. *Graph of Decreasing Cr(VI) Ion Concentration After Adsorption Process with Salacca zalacca Seed Powder Dose Variation.*

3.2.2. The Concentration of Cr(VI) After Adsorption

The biosorption process of the sample was carried out using five different dosages of *Salacca zalacca* seed powder. It aims to obtain dosage data where the salacca seed powder can adsorb Cr(VI) metal ions maximally. The amount of adsorbent is one of the factors that greatly influence the process of adsorption of heavy metals in solution. This is because of the number of adsorbent particles that can absorb heavy metals are increasing. Increasing the amount of adsorbent will cause an increase in the percentage of heavy metal that is absorbed because of the active center of the biosorbent that reacts so much too. **Figure 2** shows a decrease in the concentration of Cr(VI) ions are directly proportional to the increasing dose of *Salacca zalacca* seed powder used. This shows that the metal ion Cr(VI) can be well absorbed by the adsorbent. Significantly decreased levels of Cr(VI) were seen at doses of 3 grams and 4 grams (***Figure 2***). The amount of Cr(VI) ions adsorbed at this dose showed a very good adsorption ability from *Salacca zalacca* seeds with an absorption percentage of 68.61% and 76.21% (***Table 3***). However, at a dose of 5 grams, the concentration of Cr(VI) metal ions read by the spectrophotometer has increased again. This becomes something very interesting because it should increase as the amount of adsorbent increases, the amount of Cr (VI) ions will continue to decrease. However, the facts show different results. This phenomenon occurs because the amount of adsorbent is not balanced with the number of samples, or in other words the solution has passed the saturation. Other results might be different if the number of samples used becomes more. Of course, this greatly affects the results of the waveform absorption readings on

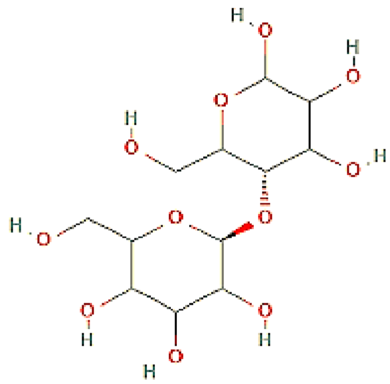

Figure 3*. Structure of Cellulose Compounds*

Reference: https://pubchem.ncbi.nlm.nih.gov/compound/CELLULOSE

the spectrophotometer. The remaining *Salacca zalacca* seed powder that is not bound to Cr(VI) remains in the solution and causes the solution to become more turbid, thereby affecting the measurement of absorbance of the sample.

Looking at the data in ***Table 3***, in this case, a dose of 4 grams of *Salacca zalacca* powder is the maximum dose that can be given to adsorb Cr (VI) ions in 100 ml samples at pH 3. At this dose, the final Cr(VI) concentration after the adsorption process read by the spectrophotometer is 1.168 ppm. This means that as many as 3.752 ppm or 76.21% Cr(VI) ions have been successfully adsorbed by the adsorbent of *Salacca zalacca* seed powder.

This good adsorption ability is because the powder of Salacca zalacca seeds is composed of cellulose. Cellulose is a polysaccharide compound containing the hydroxide group (OH) (***Figure 3***). The oxygen atom in the hydroxide group in cellulose has a strong affinity. Meanwhile, heavy metal ions are positively charged. With the properties of the oxygen atom, heavy metal ions that are positively charged will be adsorbed on the cellulose surface. This absorption occurs because of the formation of bonds between the surface of cellulose and heavy metal ions. This process plays a role in the biosorption process of heavy metals. However, there has been a decline in the quality of absorption. At a dose of 5 grams (5^{th}

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data in ***Figure 2***), the concentration of Cr(VI) ions read by the spectrophotometer increases again. In this case, This is not caused by the increasing Cr(VI) ion in the samples, but the dosage of the powder of *Salacca zalacca* seed is too excessive so that the remaining adsorbent affects the measurement of adsorbance of the sample.

4. CONCLUSIONS

Based on the data obtained in this study, *Salacca zalacca* seed powder can be used as an adsorbent for Cr(VI) ions. The adsorption ability of *Salacca zalacca* powder can be used in simple waste treatment to reduce the content of Cr(VI) ions. By setting the right conditions and dosages, the number of Cr(VI) ions can be maximally adsorbed. Thus, this method can be used as a cheaper and simpler method of processing Cr(VI) metal waste, so that it can be used by middle and lower level industries to reduce environmental damage.

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6. REFERENCES

1. Abdi, O., Kazemi, M. *J. Mater. Environ. Sci.* **2015**, 6(*5*), 1386-1399.
2. Loukidou, M. X., Zouboulis, A.I., Karapantsios, T.D., Matis, K.A. *Eng. Aspects,* **2004**, *242,* 93-104
3. Lichtfouse, E. and Schwarzbauer, J. “Environmental Chemistry For A Sustainable World Volume 1: Nanotechnology And Health Risk”, New York: Springer, **2012**.
4. Olukanni, D. O., Agunwamba, J. C., Ugwu, E. C. *American Journal Of Scientific And Industrial Research*, **2014**, 5(*2*), 81-87.
5. Rodríguez, I. A., Cárdenas-González, J. F., Juárez, V. M. M., Pérez, A. R., Zarate, M. G. M., Castillo, N. C. P. *Advances in Bioremediation and Phytoremediation* , **2018**, 43–62.
6. Acar, F. N. And Malkoc, E. *Bioresource Technology*, **2004**, *94* 13-15
7. Nagaraj, P., Aradhana, N., Svivakumar, A., Shrestha, A. K., Gowda, A.K. *Environmental Monitoring and Assessment*, **2009**, *157*, 575-582.
8. Hua, L., Chan, Y. C., Wu, Y. P., and Wu, B. Y. *Journal of Hazardous Materials*, **2009**, *163,* 1360-1368.
9. Gautam, R. K., Mudhoo, A., Lofrano, G., and Chattopadhyaya, M. C. *Journal of Environmental Chemical Engineering*, **2014**, 2, 239-259.
10. Palar, H. ”Pencemaran Dan Toksikologi Logam Berat 4th Ed., Jakarta: Rineka Cipta, **2012**.
11. Kocasoy, G. and Guvener, Z. *Environmental Geology*, **2009**, *57*(2), 291-296.
12. Davis, T. A., Volesky, B., and Mucci, A. *Water Research,* **2003**, *37*, 4311-4330.
13. Abdelfattah, I., Ismail, A. A., Al Sayed, F., Almedolab, A., Aboelghait, K.M. *Environmental Nanotechnology, Monitoring & Management*, **2016**, *6*, 176-183.
14. Kiziloz, B. *Periodico Tche Quimica*, **2019**, 16(*31*), 381–389.
15. Ordouee, B., Hazheminezhad, H. *Periodico Tche Quimica*, **2019**, 16(*32*), 228–238.
16. Sharov, A. V., Plotnikova, O. M., Evseev, V. V., Rykova, A. I., *Periodico Tche Quimica*, **2019**, 16(*32*), 516–528.
17. Widhianingrum, W.A., Inawati, Usakinah, K. N., Andriyati, V., Nugraheni, B., *Inovasi Teknik Kimia*, **2016**, 1(*2*), 84–87.
18. Andrea, C. *World Journal of Chemical Education*, **2015**, 3(*3*)*,* 70–73.
19. Minarsih, T. *Jurnal Farmasi Indonesia*, **2009**, 6(*3*), 1–5.
20. Andini, A. *Jurnal Sain Health*, 2017, 1(2), 1–4.

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Table 1. STANDARD CR(VI) MEASUREMENT RESULTS

Concentration (mg/L)	Absorbance
0,3	0,174
0,6	0,293
0,9	0,403
1,2	0,531
1,5	0,621

The data in **Table 1** is plotted into a standard curve (**Figure 1**) so that it produces a straight-line equation.

Table 2. MEASUREMENT RESULTS OF CR(VI) HEAVY METAL LEVELS ON WASTE WATER SAMPLE BEFORE ADSORPTION

Absorbance before dilution	Average	Cr(VI) metal concentration before dilution (mg/L)	Absorbance after dilution	Average	Cr(VI) metal concentration after dilution (mg/L)
1,193			0,630		
1,190	1,191	9,97	0,618	0,620	4,92
1,190			0,616		

Table 3. RESULTS OF EXAMINATION OF CR(VI) METAL ADSORPTION IN TEXTILE WASTE WATER USING *Salacca zalaccca* SEED POWDER

Mass of adsorbent (gram)	Stirring Speed	Initial Absorbance of Waste Samples	Initial Cr(VI) Metal Concentration (mg/L)	Final Absorbance of Wastewater Samples		Final concentration of Cr(VI) metal (mg/L)		Percentage of Adsorption (%)
				I	II	I	II	
	Low			0,596	0,516	4,707	4	11,52
1	*Medium*	0, 620	4,920	0,382	0,378	2,814	2,778	33
	High			0,377	0,272	2,769	1,840	53,17
	Low			0,420	0,458	3,150	3,486	32,56
2	*Medium*	0, 620	4,920	0,396	0,353	2,938	2,557	44,16
	High			0,389	0,268	2,876	1,805	52,43
	Low			0,422	0,403	3,168	3	37,31
3	*Medium*	0, 620	4,920	0,312	0,300	2,194	2,088	56,48
	High			0,234	0,243	1,504	1,584	68,61
	Low			0,402	0,403	2,991	3	39,12
4	*Medium*	0, 620	4,920	0,228	0,224	1,451	1,415	70,87
	High			0,198	0,196	1,185	1,168	**76,21**
	Low			0,363	0,360	2,641	2,619	46,54
5	*Medium*	0, 620	4,920	0,273	0,271	1,849	1,831	62,60
	High			0,243	0,240	1,584	1,550	68,15

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Research Data Processing

a. Calculation of Standard Cr(VI) Solution Series

Dilution :
$M_1V_1 = M_2V_2$

Note :
M_1 = Early molarity
V_1 = The volume of the initial solution used
M_2 = Final molarity
V_2 = The volume of solution to be made

- 100 mg/L x V_1 = 0,3 mg/L x 10 mL
  $V_1 = \frac{0,3 \ x\ 10}{100}$ = 0,03 mL
- 100 mg/L x V_1 = 0,6 mg/L x 10 mL
  $V_1 = \frac{0,6 \ x\ 10}{100}$ = 0,06 mL
- 100 mg/L x V_1 = 0,9 mg/L x 10 mL
  $V_1 = \frac{0,9 \ x\ 10}{100}$ = 0,09 mL
- 100 mg/L x V_1 = 1,2 mg/L x 10 mL
  $V_1 = \frac{1,2 \ x\ 10}{100}$ = 0,12 mL
- 100 mg/L x V_1 = 1,5 mg/L x 10 mL
  $V_1 = \frac{1,5 \ x\ 10}{100}$ = 0,15 mL

Table 4. Calculation of Cr(VI) Heavy Metal Content in Textile Waste Water Samples Before Adsorption

Absorbance before dilution	Average	Cr(VI) metal concentration before dilution (mg/L)	Absorbance after dilution	Average	Cr(VI) metal concentration after dilution (mg/L)
1,193			0,630		
1,190	1,191	9,97	0,618	0,620	4,92
1,190			0,616		

Linear Equation (from standard curve, **Figure 1**):
y = 0,113x + 0,064

Cr(VI) concentration before dilution:
1,191 = 0,113x + 0,064
0,113x = 1,191 – 0,064
$x = \frac{1,191-0,064}{0,113}$ = 9,97 mg/L

Cr(VI) concentration after dilution:
0,620 = 0,113x + 0,064
0,113x = 0,620 – 0,064
$x = \frac{0,620-0,064}{0,113}$ = 4,92 mg/L

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Calculation of Cr(VI) Heavy Metal Content in Textile Waste Water Samples Using Salak Seed Powder

- **Calculation of Cr (VI) concentration with 1 gram of *Salacca zalacca* seed mass**

Low stirring speed

I. $0{,}596 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}596 - 0{,}064$

$x = \frac{0{,}596-0{,}064}{0{,}113} = 4{,}707$ mg/L

II. $0{,}516 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}516 - 0{,}064$

$x = \frac{0{,}516-0{,}064}{0{,}113} = 4{,}00$ mg/L

Medium stirring speed

I. $0{,}382 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}382 - 0{,}064$

$x = \frac{0{,}382-0{,}064}{0{,}113} = 2{,}814$ mg/L

II. $0{,}378 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}378 - 0{,}064$

$x = \frac{0{,}378-0{,}064}{0{,}113} = 2{,}778$ mg/L

High stirring speed

I. $0{,}377 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}377 - 0{,}064$

$x = \frac{0{,}377-0{,}064}{0{,}113} = 2{,}769$ mg/L

II. $0{,}272 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}272 - 0{,}064$

$x = \frac{0{,}272-0{,}064}{0{,}113} = 1{,}840$ mg/L

- **Calculation of Cr (VI) concentration with 2 gram of *Salacca zalacca* seed mass**

Low stirring speed

I. $0{,}420 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}420 - 0{,}064$

$x = \frac{0{,}420-0{,}064}{0{,}113} = 3{,}150$ mg/L

II. $0{,}458 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}458 - 0{,}064$

$x = \frac{0{,}458-0{,}064}{0{,}113} = 3{,}486$ mg/L

Medium stirring speed

I. $0{,}396 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}396 - 0{,}064$

$x = \frac{0{,}396-0{,}064}{0{,}113} = 2{,}938$ mg/L

II. $0{,}353 = 0{,}113x + 0{,}064$

$0{,}113x = 0{,}353 - 0{,}064$

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$x = \frac{0,353-0,064}{0,113}$ = 2,557 mg/L

High stirring speed

I. 0,389 = 0,113x + 0,064

0,113x = 0,389 – 0,064

$x = \frac{0,389-0,064}{0,113}$ = 2,876 mg/L

II. 0,268 = 0,113x + 0,064

0,113x = 0,268 – 0,064

$x = \frac{0,268-0,064}{0,113}$ = 1,805 mg/L

- **Calculation of Cr (VI) concentration with 3 gram of *Salacca zalacca* seed mass**

Low stirring speed

I. 0,422 = 0,113x + 0,064

0,113x = 0,422 – 0,064

$x = \frac{0,422-0,064}{0,113}$ = 3,168 mg/L

II. 0,403 = 0,113x + 0,064

0,113x = 0,403 – 0,064

$x = \frac{0,403-0,064}{0,113}$ = 3,00 mg/L

Medium stirring speed

I. 0,312 = 0,113x + 0,064

0,113x = 0,312 – 0,064

$x = \frac{0,312-0,064}{0,113}$ = 2,194 mg/L

II. 0,300 = 0,113x + 0,064

0,113x = 0,300 – 0,064

$x = \frac{0,300-0,064}{0,113}$ = 2,088 mg/L

High stirring speed

I. 0,234 = 0,113x + 0,064

0,113x = 0,234 – 0,064

$x = \frac{0,234-0,064}{0,113}$ = 1,504 mg/L

II. 0,243 = 0,113x + 0,064

0,113x = 0,243 – 0,064

$x = \frac{0,243-0,064}{0,113}$ = 1,584 mg/L

- **Calculation of Cr(VI) concentration with 4 gram of *Salacca zalacca* seed mass**

Low stirring speed

I. 0,402 = 0,113x + 0,064

0,113x = 0,402 – 0,064

$x = \frac{0,402-0,064}{0,113}$ = 2,991 mg/L

II. 0,403 = 0,113x + 0,064

0,113x = 0,403 – 0,064

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$x = \frac{0,403-0,064}{0,113}$ = 3,00 mg/L

Medium stirring speed

I. 0,228 = 0,113x + 0,064
0,113x = 0,228 – 0,064
$x = \frac{0,228-0,064}{0,113}$ = 1,451 mg/L

II. 0,224 = 0,113x + 0,064
0,113x = 0,224 – 0,064
$x = \frac{0,224-0,064}{0,113}$ = 1,415 mg/L

High stirring speed

I. 0,198 = 0,113x + 0,064
0,113x = 0,198 – 0,064
$x = \frac{0,198-0,064}{0,113}$ = 1,185 mg/L

II. 0,196 = 0,113x + 0,064
0,113x = 0,196 – 0,064
$x = \frac{0,196-0,064}{0,113}$ = 1,168 mg/L

- **Calculation of Cr (VI) concentration with 5 gram of *Salacca zalacca* seed mass**

Low stirring speed

I. 0,363 = 0,113x + 0,064
0,113x = 0,363 – 0,064
$x = \frac{0,363-0,064}{0,113}$ = 2,641 mg/L

II. 0,360 = 0,113x + 0,064
0,113x = 0,360 – 0,064
$x = \frac{0,360-0,064}{0,113}$ = 2,619 mg/L

Kecepatan Pengadukan *medium*

I. 0,273 = 0,113x + 0,064
0,113x = 0,273 – 0,064
$x = \frac{0,273-0,064}{0,113}$ = 1,849 mg/L

II. 0,271 = 0,113x + 0,064
0,113x = 0,271 – 0,064
$x = \frac{0,271-0,064}{0,113}$ = 1,831 mg/L

High stirring speed

I. 0,243 = 0,113x + 0,064
0,113x = 0,243 – 0,064
$x = \frac{0,243-0,064}{0,113}$ = 1,584 mg/L

II. 0,240 = 0,113x + 0,064
0,113x = 0,240 – 0,064
$x = \frac{0,240-0,064}{0,113}$ = 1,550 mg/L

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b. Calculation of Cr (VI) Heavy Metal Absorption Percentage

$$\% = \frac{Initial\ Concentration - Final\ Concentration}{Initial\ COncentration} \text{ x } 100\ \%$$

- **Percentage decrease in Cr(VI) concentration with 1 gram *Salacca zalacca* seed mass**

  Low Stirring Speed

  $X = \frac{4{,}707+4}{2} = 4{,}353$

  $\% = \frac{4{,}920-4{,}353}{4{,}920} = 11{,}52\ \%$

  Medium Stirring Speed

  $X = \frac{3{,}814+2{,}778}{2} = 3{,}296$

  $\% = \frac{4{,}920-3{,}296}{4{,}920} = 33\ \%$

  High Stirring Speed

  $X = \frac{2{,}769+1{,}840}{2} = 2{,}304$

  $\% = \frac{4{,}920-2{,}304}{4{,}920} = 53{,}17\ \%$

- **Percentage decrease in Cr(VI) concentration with 2 gram *Salacca zalacca* seed mass**

  Low Stirring Speed

  $X = \frac{3{,}150+3{,}486}{2} = 3{,}318$

  $\% = \frac{4{,}920-3{,}318}{4{,}920} = 32{,}56\ \%$

  Medium Stirring Speed

  $X = \frac{22{,}938+2{,}557}{2} = 2{,}747$

  $\% = \frac{4{,}920-2{,}747}{4{,}920} = 44{,}16\ \%$

  High Stirring Speed

  $X = \frac{2{,}876+1{,}805}{2} = 2{,}340$

  $\% = \frac{4{,}920-2{,}340}{4{,}920} = 52{,}43\ \%$

- **Percentage decrease in Cr(VI) concentration with 3 gram *Salacca zalacca* seed mass**

  Low Stirring Speed

  $X = \frac{3{,}168+3}{2} = 3{,}084$

  $\% = \frac{4{,}920-3{,}084}{4{,}920} = 37{,}31\ \%$

  Medium Stirring Speed

  $X = \frac{2{,}194+2{,}088}{2} = 2{,}141$

  $\% = \frac{4{,}920-2{,}141}{4{,}920} = 56{,}48\%$

  High Stirring Speed

  $X = \frac{21{,}504+1{,}584}{2} = 1{,}544$

  $\% = \frac{4{,}920-1{,}544}{4{,}920} = 68{,}61\ \%$

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- **Percentage decrease in Cr(VI) concentration with 4 gram *Salacca zalacca* seed mass**

  Low Stirring Speed

  $X = \frac{2,991+3}{2} = 2,995$

  $\% = \frac{4,920-2,995}{4,920} = 39,12\ \%$

  Medium Stirring Speed

  $X = \frac{1,451+1,415}{2} = 1,433$

  $\% = \frac{4,920-1,433}{4,920} = 70,87\ \%$

  High Stirring Speed

  $X = \frac{1,185+1,168}{2} = 1,176$

  $\% = \frac{4,920-1,176}{4,920} = 76,21\ \%$

- **Percentage decrease in Cr(VI) concentration with 5 gram *Salacca zalacca* seed mass**

  Low Stirring Speed

  $X = \frac{2,641+2,619}{2} = 2,63$

  $\% = \frac{4,920-2,63}{4,920} = 46,54\ \%$

  Pada Kecepatan *medium*

  $X = \frac{1,849+1,831}{2} = 1,84$

  $\% = \frac{4,920-1,84}{4,920} = 62,60\ \%$

  High Stirring Speed

  $X = \frac{1,584+1,550}{2} = 1,567$

  $\% = \frac{4,920-1,567}{4,920} = 68,15\ \%$

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