Corncob Activated Carbon Adsorption Capacity (Zea mays L.) Against Rhodamine B. Dyes

Sudarmi
Faculty of Science and Technology, UIN Alauddin Makassar

ABSTRACT
The aims of this experimental research are to determine the optimum of contact time, influence of stirring against absorbing power, and adsorption capacity of activated carbon corn cob to pigment Rhodamine B. This research was done to vary contact time and first concentration of pigment Rhodamine B. The result of this research showed that optimum of time contact needed activated carbon corn cob to adsorption pigment Rhodamine B 45 minutes, rapid process way would be more biggest with more big the contact time until reach optimum time and adsorption capacity of activated carbon corn cob against the pigment Rhodamin B were 2,2255 mg/g. The value was more biggest than the adsorption capacity of activated carbon waste of sugar cane against pigment Rhodamine B were 2,078 mg/g. Isotherm system of the activated carbon corn cob to pigment Rhodamin B followed isotherm system Langmuir with adsorption capacity were 2,2255 mg/g. Isotherm system Freundlich value of adsorption capacity were 1.481 mg/g.

INTRODUCTION
Today's environmental pollution occurs everywhere, both in the air, land and aquatic environments. Substances that pollute the environment can be metals and also dyes. There are 2 kinds of dyes, namely natural dyes and artificial (synthetic) dyes. Based on the solubility of synthetic dyes, there are two kinds, namely dyes and lakes. Dyes are water-soluble dyes and are traded in the form of granules, liquids, color mixtures and pastes. Dyes are used to color carbonated drinks, soft drinks, breads, pastries, dairy products, sausage wrappers, and more. Lakes are pigments made by deposition of adsorbed dyes on the base material and are commonly used in coating tablets, cake mixes, cakes and donuts. One of the dyes that have been banned but is still widely used today is Rhodamine B.

Rhodamine B with the molecular formula C28H31N2O3Cl is one of the synthetic dyes that should not be used for food. Rhodamine B is in the form of green crystals or reddish-purple powder, very soluble in water which will produce a blush-red color and strong fluorescence. Besides being easily soluble in water, it is also soluble in alcohol, HCl and NaOH. Rhodamine B is usually used in
paper coloring and the textile industry, in the laboratory it is used as a reagent for the identification of Pb, Bi, Co, Au, Mg, and Th. Rhodamine B is still widely used to color various types of food and beverages (especially for the economically weak groups), such as cakes, sauces, syrup, crackers and tofu.

Several methods of removing color in industrial waste are carried out biologically, chemically, physically or by a combination of the three processes. Color removal by chemical means is carried out with coagulant while physical method is carried out by sedimentation and adsorption. Overcoming the problem of pollution in the aquatic environment can be done by using the deposition method followed by filtering, absorption using activated carbon, zeolite, diatomaceous earth, alumina, silica gel and silica sand.

Activated carbon is used because it is cheap and easy to obtain. The characteristics of activated carbon are the yield value ranging from 54.12-64.41%, moisture content 32-8.48%, volatile matter content 15.9-26.2%, ash content 3-13%, bound carbon content 60.8-79.3%, absorption of benzene 11.64-14.48%, absorption to iodine 196.41-1230.93 mg/g and absorption to methylene blue 18.87-130.88 mg/g. Activated carbon can be used to absorb metals because it has a very large pore space with a certain size. These pores can trap very fine particles (molecules) especially heavy metals and trap them there. Activated carbon has been used to remove heavy metals. Heavy metal ions are attracted by activated carbon and attached to its surface by a combination of complex physical forces and chemical reactions. Activated carbon has a very wide porous network that changes shape to accept impurity molecules, both large and small. The effectiveness of activated carbon adsorption on lead metal Pb2+ has been shown in the NSF (National Sanitation Foundation) certificate which reflects the Langmuir isotherm where the heavy metal adsorption of Pb will continue until it reaches the equilibrium point and the adsorption process will no longer run or stop even though the activated carbon dose is increased.

Activated carbon has also been used to absorb dyes. The results of the research on the adsorption of Rhodamine B dye using activated carbon from cocoa shells obtained the optimum pH at pH 6.10. The surface of the activated carbon at that pH will be positively charged, resulting in a strong attraction to Rhodamine B dye. Activated carbon from bagasse can adsorb the dye. Rhodamine B with an optimum time of 60 minutes. One of the wastes that can be used as a source of activated carbon is corn cobs. Corn production in Indonesia annually reaches 52,766 tons and the resulting corn cobs become waste that can pollute the environment.

**RESEARCH METHOD**

1. **Research variable**
   This study consisted of two variables, namely contact time (stirring) as the independent variable, and the adsorption capacity of corncob activated carbon on Rhodamine B dye as the dependent variable.

2. **Research Time and Location**
   This research was carried out from March to May 2010. The grinding process was carried out at the Chemical Science and Technology Laboratory of Alauddin State Islamic University Makassar, the sieving process was carried out at the Makassar Plantation Product Industry Center Laboratory, Makassar Health Laboratory.

3. **Tools and materials**
   a. **Tool**
   The tools used in this research include: UV-1601 Shimadzu Spectrophotometer, carbonization can, sifter, Crusher, Sartorius TE 124S scale, electric furnace 48000 Furnace, oven, porcelain crucible, measuring flask, desiccator, beaker, Erlenmeyer, glass measuring tape, goiter, petri dish, funnel, magnetic stirrer & thermometer, spray bottle, aluminum foil, Whatman No. filter paper, 42, stirring rod, spatula, dropper, pH paper, and tissue.
b. Ingredient
The materials used in this study were corn cobs obtained from Bulukumba Regency, distilled water, 9% (w/v) CaCl2 solution and Rhodamine B dye.

c. Research procedure
The research procedure consisted of: Preparation of Corncob Activated Carbon, Preparation of Rhodamine B Dyes Main Solution, Measurement of the adsorption power of corncob activated carbon on Rhodamine B dye with variations in stirring contact time, Preparation of a standard solution series, Measurement of the adsorption capacity of corncob activated carbon to Rhodamine B dye based on optimum time.

d. Data analysis technique.
From the results of the analysis, a graph is made between the adsorbent and the concentration of Rhodamine B dye (ppm), in order to obtain a calibration curve with a straight line equation:

\[ Y = ax + b \] (1)

Where: 
- \( Y \) = absorbance of Rhodamine dye B
- \( x \) = concentration of Rhodamine B dye (ppm)
- \( a \) = slope (slope)
- \( b \) = intercept (intercept)

RESULTS AND DISCUSSIONS

1. Research result
   a. Determination of the Optimum Contact Time (stirring) Required by Corn Cob Activated Carbon to Adsorb Rhodamine B Dyes
      The results obtained from the effect of contact time (stirring) for determining the optimum time of adsorption of corncob activated carbon on Rhodamine B dye can be seen in Table 1:

| Contact time (minutes) | Rhodamine kesetimbangan equilibrium concentration B, Ce (mg/L) | Adsorption effectiveness, x/m or W (mg/g) |
|------------------------|---------------------------------------------------------------|------------------------------------------|
| 15                     | 0.8071                                                        | 0.9596                                   |
| 30                     | 0.5883                                                        | 0.9705                                   |
| 45                     | 0.4282                                                        | 0.9785                                   |
| 50                     | 0.4320                                                        | 0.9784                                   |
| 55                     | 0.4208                                                        | 0.9784                                   |

**Initial concentration of Rhodamine B, Co = 20 ppm**

The relationship between the effectiveness of corncob activated carbon adsorption on Rhodamine B dye and the stirring contact time can be determined by making a graph plotting the adsorption time (minutes) with the effectiveness of corncob activated carbon adsorption on Rhodamine B dyestuff (mg/g).

\[ \text{Effeutif adsorpsi, } \frac{A}{m}, A = \text{mg/L} \]

\[ \text{Waktu kontak (menit)} \]

Figure 1. Graph of the relationship between adsorption time and adsorption effectiveness as function of time (initial concentration of Rhodamine B 20 ppm).
b. Measurement of Corncob Activated Carbon Adsorption Capacity Against Rhodamine B.

The results obtained from the measurement of the adsorption capacity of corncob activated carbon against Rhodamine B dye can be seen in Table 2.

Table 2. The effectiveness of corncob activated carbon adsorption on Rhodamine B dye as a function of the initial concentration of Rhodamine B dye

| Co (mg/L) | Ce (mg/L) | Co-Ce (mg/L) | Adsorption effectiveness x/m or W (mg/g) |
|----------|-----------|--------------|----------------------------------------|
| 20       | 0.4115    | 19.3885      | 0.9734                                 |
| 30       | 0.683     | 29.317       | 1.4658                                 |
| 40       | 1.1874    | 38.8126      | 1.0406                                 |
| 50       | 5.4887    | 44.5113      | 2.2255                                 |
| 60       | 16.5477   | 43.4523      | 2.1726                                 |

The increase in the effectiveness of corncob activated carbon adsorption on Rhodamine B dye can be seen through a graph with a plot between the effectiveness of corncob activated carbon and the adsorbed Rhodamine B dye concentration. From the graph, it can be seen that the highest adsorption capacity value of corncob activated carbon against Rhodamine B dye reached the optimum point or in other words, the effectiveness value decreased which was not significant or even almost constant. The optimum concentration used by corncob activated carbon to absorb Rhodamine B dye can also be seen from the graph below. The graph of the effectiveness of the adsorption of corncob activated carbon with the adsorbed concentration of Rhodamine B dye can be seen in the following graph:

![Graph of the relationship between the effectiveness of Rhodamine B adsorption by activated carbon on corn cobs (x/m) and the concentration of the dye Rhodamine B adsorbed (contact time (stirring) = 45 minutes, initial concentrations of 20, 30, 40, 50 and 60 ppm).](image)

The relationship between the adsorption effectiveness of corncob activated carbon on Rhodamine B dye and the concentration of Rhodamine B dye solution at equilibrium to determine the adsorption capacity of corncob activated carbon can be seen through the graph of the relationship between Ce and x/m or W (adsorption effectiveness).

![Graph of the relationship between the effectiveness of corncob activated carbon adsorption on substances Rhodamine B color (x/m) with the remaining concentration of Rhodamine B dye (contact time = 45 minutes, initial 20,30,40,50 and 60 ppm).](image)
The adsorption isotherm of corncob activated carbon against Rhodamine B dye based on the Freundlich and Langmuir equations can be studied by graphing the relationship between log Ce and log x/m for the Freundlich and Ce adsorption model with Ce/W for the Langmuir adsorption model. The isotherm graph can show that activated carbon tends to follow the Langmuir or Freundlich isotherm pattern based on the linear regression value (R2) which is closer to 1.

Figure 4. Freundlich isotherm graph for cob activated carbon adsorption corn to Rhodamine B dye.

Figure 5. Graph of Langmuir isotherm for cob activated carbon adsorption corn to Rhodamine B dye.

2. Discussion
a. The optimum contact time required by activated carbon of corn cobs to absorb Rhodamine B dye

The adsorption equilibrium can be known if there is no significant change in concentration in the solution or in the adsorbent over a varied time. In Figure 6, it can be seen that the effectiveness of corncob activated carbon adsorption on Rhodamine B dye (x/m) increased with increasing stirring time. From the results obtained, the optimum adsorption time occurred at a contact time of 45 minutes with the concentration of adsorbed Rhodamine B dye 0.9785 mg/g.

After 45 minutes had passed, namely at the contact time of 50 minutes, there was a slight decrease in the concentration of the adsorbed Rhodamine B dye which was not significant, even almost constant. In other words, the concentration of Rhodamine B dye in solution and in the adsorbent is constant. This situation is in accordance with the theory that the longer the time used, the more solute will be adsorbed. However, the amount of solute adsorbed will be saturated when it reaches the limit value, which is caused by the pores on the surface of the corncob activated carbon (adsorbent) being saturated, so that the adsorption on the surface tends to reach the maximum limit. Corn cobs are able to absorb Rhodamine B dye with an optimum time of 45 minutes, while absorption using bagasse has an optimum time of 60 minutes, this proves that corn cobs are more efficient to use in absorbing Rhodamine B dye. Absorption of Rhodamine B dye using...
Corncob Activated Carbon Adsorption Capacity (Zea mays L.) Against Rhodamine B Dyes (Sudarmi)

activated carbon from kapok seeds obtained an optimum contact time of 30 minutes with an adsorption capacity of 15,4292 mg/g48, from these results it means Kapok seeds have the ability to absorb Rhodamine B dye better due to the larger pore size so that it can absorb Rhodamine B dye more and more efficiently. In this study, the contact time (stirring) for 45 minutes was the optimum time, where Rhodamine B could not be adsorbed more and this time was used for further research. The absorption of Rhodamine B dye using activated carbon from kapok seeds obtained an optimum contact time of 30 minutes with an adsorption capacity of 15,4292 mg/g48, from these results it means that kapok seeds have the ability to absorb Rhodamine B dye better due to the larger pores so that it can absorb Rhodamine B dye more and more efficiently. In this study, the contact time (stirring) for 45 minutes was the optimum time, where Rhodamine B could not be adsorbed more and this time was used for further research. The absorption of Rhodamine B dye using activated carbon from kapok seeds obtained an optimum contact time of 30 minutes with an adsorption capacity of 15,4292 mg/g48, from these results it means that kapok seeds have the ability to absorb Rhodamine B dye better due to the larger pore size so that it can absorb Rhodamine B dye more and more efficiently. In this study, the contact time (stirring) for 45 minutes was the optimum time, where Rhodamine B could not be adsorbed more and this time was used for further research.

The longer the stirring time of the activated carbon solution that has been mixed with the Rhodamine B dye solution, the faster the activated carbon will absorb the Rhodamine B dye in the solution. This is due to the fact that the presence of stirring means that the particles in the solution are in contact with the activated carbon particles. This stirring provides an opportunity for the activated carbon to come into contact with the adsorbed particles.

The adsorption of corncob activated carbon on Rhodamine B dye will be faster and increase along with the longer stirring time until it reaches the optimum point, which is the point where the activated carbon has reached saturation because the pores in the corncob activated carbon are fully filled. so it is no longer able to absorb more Rhodamine B dye.

Activated carbon from corn cobs can be used for water filtration so that it has no odor, pH 6.56 and can reduce Fe, BOD, COD levels in water. 50 Activated carbon from corn cobs is also able to reduce the number of cooking oil with the addition of activated carbon in succession, 2, 3, 4, 5 grams in oil 5 times.

b. Corncob Activated Carbon Adsorption Capacity Against Rhodamine B Dyes

The increase in the effectiveness of corncob activated carbon adsorption on Rhodamine B dye was due to the higher initial concentration of Rhodamine B dye, the greater the amount of Rhodamine B dye dissolved so that the more Rhodamine B dye molecules were adsorbed by the activated carbon. corncob.

From the results obtained, it can be seen that the maximum adsorption power of corn cobs activated carbon against Rhodamine B dye with a contact time (stirring) of 45 minutes is 44,5123 ppm (2.2255 mg/g). This condition occurs in variations in the initial concentration of 50 ppm Rhodamine B dye. Furthermore, in the variation of the initial concentration of Rhodamine B dye at 60 ppm, the amount of Rhodamine B dye adsorbed slightly decreased, namely 43,4523 ppm (2.1726 mg/g). This is because the pores on the surface of the corncob activated carbon (adsorbent) are fully filled (saturated) so that they cannot adsorb (adopted) the Rhodamine B dye molecule which is even larger (reaching the maximum limit).
The adsorption isotherm of corncob activated carbon can be seen in Figures 9 and 10. From the two isotherm graphs, it can be seen that the adsorption isotherm of corncob activated carbon to Rhodamine B dye tends to follow the Langmuir equation, because the linear regression value (R²) for the isotherm curve Langmuir is closer to 1 which is 0.9991. While the linear regression value (R²) for the Freundlich isotherm curve is only 0.6855. This indicates that the adsorption of activated carbon from corn cobs on Rhodamine B dye is physical. This physical adsorption occurs due to the interaction between the solid face phase of corncob activated carbon and Rhodamine B dye molecules present in the solution. In this adsorption no ion exchange occurs, because the molecular size of Rhodamine B dye is very large and adsorption occurs at neutral pH. So that, It is possible that the Rhodamine B dye molecule was only trapped (trapped) in the pores on the surface of the corncob activated carbon. This is what causes Rhodamine B dye to be adsorbed by corncob activated carbon.

The results of data analysis in Appendix 9 show that the adsorption capacity of corncob activated carbon for the Langmuir isotherm pattern (b) is $2.222 \text{ mg/g}$, meaning that each gram of corncob activated carbon is able to absorb $2.222 \text{ mg of Rhodamine B dye contained in the solution}$. Meanwhile, the Freundlich ($k$) isotherm pattern is $1.481 \text{ mg/g}$.

**CONCLUSION**

From the results of the analysis and discussion, it can be concluded that the optimum contact time required by activated carbon of corn cobs (Zea mays L.) to adsorb Rhodamine B dye is 45 minutes. The adsorption capacity of corncob activated carbon (Zea mays L.) against Rhodamine B dye was 44.5113 ppm ($2.2255 \text{ mg/g}$). The adsorption isotherm pattern of corncob activated carbon (Zea mays L.) against Rhodamine B dye, more followed the Langmuir isotherm pattern than the Freundlich isotherm pattern with the adsorption capacity value for the Langmuir isotherm pattern $b = 2.222 \text{ mg/g}$ and the linear regression value (R²) was 0.999 while for Freundlich isotherm pattern $k = 1.481 \text{ mg/g}$ and linear regression (R²) is 0.685.

**ACKNOWLEDGEMENTS**

To the industry to use activated carbon corn cobs against waste to absorb Rhodamine B dye before being discharged into the environment.

**REFERENCES**

Bambang Piluharto. 2008. Study of Physical Properties of Nata de Coco Thin Film as Ultrafiltration Membrane. Lecturer of the Department of Chemistry, Faculty of Mathematics and Natural Sciences, University of Jember.

Benjamin Lakitan. 2010. Fundamentals of Plant Physiology. Press Eagle. Jakarta

Budianto. KA. 2004. Applied Microbiology. First edition. Third printing. UMM. Poor Press.

Buckle Edward Fleed Watton. 1987. Food Science. Jakarta : University of Indonesia Press

Ministry of Religion of the Republic of Indonesia. 2005. The Qur’an and its translation. CV Publisher J-AKT. Bandung.

Fardiaz, Srikandi. 1992. Food Microbiology. Department of Education and Culture. PAU Food and Nutrition. Bogor Agricultural Institute.

Office of the Deputy Minister of Research and Technology for the Utilization and Socialization of Science and Technology. Building II BPP Teknologi 6th Floor. JI. MH Thamrin 8 Jakarta 10340. http://www.ristek.go.id. Downloaded March 28, 2010.

Lay, BW and Hastowo. 1982. Microbiology. Rajawali Press Jakarta Lehninger. AL 1988. Fundamentals of Biochemistry. Volume : 1. Erlangga. Jakarta.

Mellawati, R., et al. 2003. Cultivation of Acetobactersp. RMG-2 on several carbon and nitrogen sources and their effect on cellulose production. Journal of Biosphere 2 (2) p.43-49.

Moh. Earthquake. et al. 2008. Synthesis of Ability Test Of Nata de Coco As Ultrafiltration Membrane To Remove...
Corncob Activated Carbon Adsorption Capacity (Zea mays L.) Against Rhodamine B Dyes (Sudarmadji)

Dyes In Artificial Wastewater. Trisakti University.
Mohd. Sale Suwandi. Seizing Future Opportunities in Membrane Technology: achievements, efforts and challenges. http://www.penerbit.ukm.my/f199-6htm. downloaded March 30, 2010.
Nurfiningsih. Making Nata de Corn with Acetobacter Xylinum, Department of Chemical Engineering, Faculty of Engineering, Diponegoro University, http://www.clicktoconvert.com. Download on April 2, 2010
Octavia Revina, 2003. “Making Nata de Banana from Banana Peel by Fermentation”, UNTAG Semarang
Piluharto, B, 2008. Study of Physical Properties of Nata de Coco Thin Films as Ultrafiltration Membranes, Faculty of Mathematics and Natural Sciences, University of Jember. Jember.
Pisesidhartha. E. et al, Preparation of Nata de coco-ethylenediamine membrane and study of its binding characteristics to Cu2+ ions. Faculty of Mathematics and Natural Sciences, University of Jember. Jember.
PL Tobing and Z. Poelengan. 2000. Biological control of palm oil mill effluent in Indonesia. PPKS News.
Ridwan Kusniadi, 2009. The relationship between varieties and rice composition. IPB Siti Agustina, 2006. The use of membrane technology in palm oil industrial wastewater treatment.
Sudarmadji. S. 1984. Analytical Procedures for Foodstuffs and Agriculture. Third edition. Liberty Publishers. Yogyakarta
Sutarminingsih, Ch. Lilies. 2004. Business Opportunity : Nata De Coco, Kanisius, Yogyakarta.
Warisno. Easy and Practical to Make Nata de Coco. Media Library. Jakarta Winarno. FG Food Chemistry and Nutrition. Eighth print. Publisher PT Gramedia Pustaka. Jakarta.
Wirakusumah, Emma S. 1995. Fruits and Vegetables for Therapy. Jakarta : Self-help. Yuliani, Galuh, 2005. Making Cellulose Acetate Membranes from Nata de Coco, Master's Thesis, Postgraduate Program, Bandung Institute of Technology, Bandung.