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Making Activator Materials Active Carbon From Wedi Skin Salak (Salacca edulis Reinw) With ZnCl2 Activator as Adsorbent to Reduce Fenol Content

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Abstract

Making Activator Materials Active Carbon From Wedi Skin Salak (Salacca edulis Reinw) With ZnCl2 Activator as Adsorbent to Reduce Fenol Content. *Wedi salak skin in Bojonegoro as an activated carbon material can provide an alternative for activated carbon manufacturing materials by utilizing environmentally friendly natural materials. The wedi salak skin is modified by treatment in the sun, in the roast, and in the oven in the manufacture of activated carbon which is then activated with ZnCl2 and then tested the adsorbs power of this salak skin activated carbon against phenol reduction. The adsorbent material that reduces the concentration of phenol the most is the roasted adsorbent material with a final phenol concentration of 2.15 mg/L so that the concentration of phenol absorbed is 297.85 mg/L at a mass of 1.5 g. The results of the analysis show that each variation of the activated carbon variation can reduce the concentration of phenol. The results obtained from this study are the type of activated carbon material whose highest absorption efficiency is the type of activated carbon material roasted at 99.28% with a mass of activated carbon of 1.5 g. Based on the results of the analysis, it can be seen that each variation of the type of activated carbon material will experience a decrease in concentration as the mass of the adsorbent increases. The greater the mass of the adsorbent, the adsorption ability will also increase. Each type of activated carbon material also experienced an increase in percent removal along with an increase in adsorbent mass. The results of research on the effect of activated carbon mass, also show that the adsorption capacity value decreases with increasing adsorbent mass. In this research data, the largest capacitance value was 112.87 mg/g at the smallest mass of 0.5g. The decrease in adsorption capacity is caused by the active side of the adsorbent that has not all bonded with the adsorbate.*

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INTRODUCTION

Activated carbon is an amorphous form of carbon characterized by a flat, hexagonal lattice structure, with C atoms covalently at each corner whose surface area ranges from 300 m2/g to 3500 m2/g and this is related to the internal pore structure so that it has properties of internal pores associated with the internal pore structure so that it has properties as an adsorbent. (Meilita Taryana, 2002). The characteristics of high-quality and good activated carbon are that activated carbon has a large surface area and high pore volume(Hartanto and Ratnawati, 2010). Recent studies have highlighted the significance of agricultural waste as a source of inexpensive and renewable raw materials for the production of activated carbon. Materials such as date seeds, corn cobs, coconut shells, cassava peels, and peanut shells are commonly used. Salak (Salacca edulis Reinw) skin, in particular, has been identified as a

potential agricultural waste for the production of activated carbon (Chadrudee Sirilamduan, 2011).

Numerous studies have investigated the production of activated carbon. Pradhan (2011) produced activated carbon from paper sludge waste using ZnCl2 as an activator. This activation method resulted in activated carbon with excellent porosity, a specific surface area of 737.6 m2/g, and a high iodine value of 764.8 mg/g. Namasivayam and Sangeetha (2005) created activated carbon from coconut fiber, also using ZnCl2, which proved to be an effective adsorbent for nitrate removal from solution. Additionally, In the research of Sodeinde (2012), it was found that the presence of activated carbon from coconut shells increased the catalyst conversion in cobalt (III) reduction.

Salak (Salacca edulis Reinw) is native to Southeast Asia and features an egg-like shape. Its brown skin resembles a snakeskin, covered in regular scales contributing to its reptilian appearance. Each fruit contains three seeds enveloped in white flesh. In Indonesia, various salak cultivars exist, though most are characterized by an astringent taste. After peeling, the skin is typically discarded as waste; however, in this study, it is utilized as a raw material for producing activated carbon. According to research (Nugroho, 2014) salak (Salacca edulis Reinw) has a chemical content in the form of carbohydrates calculated from its flour 88.35%, consisting of 28.98% cellulose and 59.37% of other carbohydrates identified as hemicellulose in the form of mannan, or equivalent to 36.28% of carbohydrates from fresh salak seeds consisting of 11.90% cellulose and 24.38% mannan. Cellulose and active compounds contained in salak seeds can be used as adsorbents.

Activated carbon functions through an adsorption process, whereby substances to be removed adhere to its surface. Numerous studies have highlighted the advantages and applications of activated carbon for the absorption of both organic and inorganic compounds. Activated carbon that has been increased to a larger surface area can be utilized for various applications, including as a decolorizer, flavor remover, deodorizer, and purifying agent in the food industry. It is also widely used in water purification processes both in the production of drinking water and in the handling of waste (Wu, 2004). The rising demand for activated carbon is driven by its diverse industrial applications, which include its use in medicine, food processing, beverages, water purification, pharmaceuticals, and chemical industries. This increasing demand has prompted researchers to explore alternative materials that can serve as substitutes for activated carbon (Pambayun, Gilar. S, et al, 2013).

Based on the background previously mentioned, this study aims to explore the potential of Wedi Salak peel waste from Bojonegoro as a material for activated carbon production. The research focuses on providing an alternative method for creating activated carbon by utilizing the peel of Wedi Salak. The peel undergoes modifications through sun treatment, roasting, and oven drying before activation with ZnCl2. Subsequently, the adsorptive capacity of this activated carbon is evaluated for phenol reduction.

The introduction contains the purpose of the article/research that is formulated and presented by an adequate introduction and avoids detailed references and research result presentations. The research urgency, supporting facts, and data must be included. A preliminary research result should be explained as the basis of the research. Before mentioning the objective/s, a gap analysis must be elucidated. The gap analysis states the difference/s between the research and
other previous studies. At this point, the novelty will be apparent. The research stance must be included, whether it corrects, debates, or supports the previous research.

METHODS

1. Sample Preparation

This research was conducted experimentally in the laboratory, involving three distinct treatments for the production of activated carbon from Salak skin, namely sun drying, roasting, and oven drying. First, the salak skin waste was washed thoroughly, and then three treatments were carried out, namely drying, roasting, and baking in the oven. Sample A with salak skin treatment was dried in the sun for 7 days until very dry and a constant weight was obtained. Sample B with salak skin treatment was roasted over low heat for 1.5-2 hours until it became charcoal and reached a constant weight. Sample C with salak skin treatment was baked in an oven at 110℃ for 2 hours until constant weight was obtained.

2. Carbon Manufacturing

Subsequently, these three samples were pulverized by first blending them into smaller pieces, followed by grinding using a mortar to achieve a smaller and finer powder. The three powders were then sifted using a 50 mesh sieve, with Sample A designated for sun-dried salak skin carbon, Sample B for roasted salak skin carbon, and Sample C for oven-dried salak skin carbon. Furthermore, chemical activation was carried out on all three samples using a ZnCl2 activator.

3. Activation of Activated Carbon

Furthermore, samples A, B, and C were activated with ZnCl2 in a ratio of 1:1.5. Here ZnCl2 is used with a concentration of 2 mg/L. The mixture of carbon and activator was stirred for 2 hours to get homogeneous results. Then proceed with washing and settling for approximately 24 hours. After that, the activated carbon precipitate was washed with distilled water until PH 6-7 was obtained. Then the sample is dried in the oven for 2 hours so that the activated sample is obtained and ready to use.

4. Evaluation of Activated Carbon for Phenol Adsorption

The next stage of activated carbon that has been activated is put into an Erlenmeyer flask with a weight variation of 500, 1000, and 1500 mg of activated carbon. Then added phenol solution of as much as 200 mL (concentration of 300mg/L) and stirred for 1 hour the solution was separated between the filtrate and the residue by filtering. Then the sample was inserted in UV-Vis spectrophotometry (λ) 270.0 nm) to get the concentration of phenol absorbed (Ari Dwi Putranto and M. Razif, 2006). Subsequently, the phenol adsorption efficiency was calculated.

5. Determination of Langmuir and Freundlich Isotherms

To determine the adsorption capacity, the relationship between the final concentration and the mass of kluwak shell-activated carbon was established. The Langmuir isotherm equation was derived by plotting Ce against Ce/W for each type of activated carbon. In contrast, the Freundlich isotherm equation is obtained by plotting log Ce against log W for each type of carbon (Ari Dwi Putranto and M. Razif, 2006).

The method used should be accompanied by references; the relevant modification should be explained. The procedure and data analysis technique should be emphasized in a literature review article. The stages and analysis of the research must be explained in detail. The research method should be presented in this section with a caption. Image captions are placed as part of the figure caption, not as part of the image. The methods used in completing the research are listed in this section.

RESULTS AND DISCUSSION

1. Adsorption Ability of Salak Bark

The efficiency of phenol absorption in this study uses simulated phenolic waste with an initial concentration of 300 ppm. Below is presented Table 1 which shows the results of phenol absorption efficiency of salak wedi peel activated carbon with mass variations for each exploration of activated carbon treatment.

Table 1. Sorption Efficiency and Adsorption Capacity of Phenol

No.	Sample (g)	Final Concentration (mg/L)	Absorption Efficiency(%)	Adsorption Capacity(mg/g)
1.	Sun-dried Carbon0.5	24.97	91.68	110.01
2.	Sun-dried Carbon1.0	16.75	94.42	56.65
3.	Sun-dried Carbon1.5	7.45	97.51	39.01
4.	Oven-dried Carbon 0.5	20.51	93.16	111.79
5.	Oven-dried Carbon 1.0	12.16	95.95	57.57
6.	Oven-dried Carbon1.5	5.09	98.3	39.32
7.	Roasted carbon 0.5	17.81	94.06	112.87
8.	Roasted carbon 1.0	4.9	98.36	59.02
9.	Roasted carbon 1.5	2.15	99.28	39.71

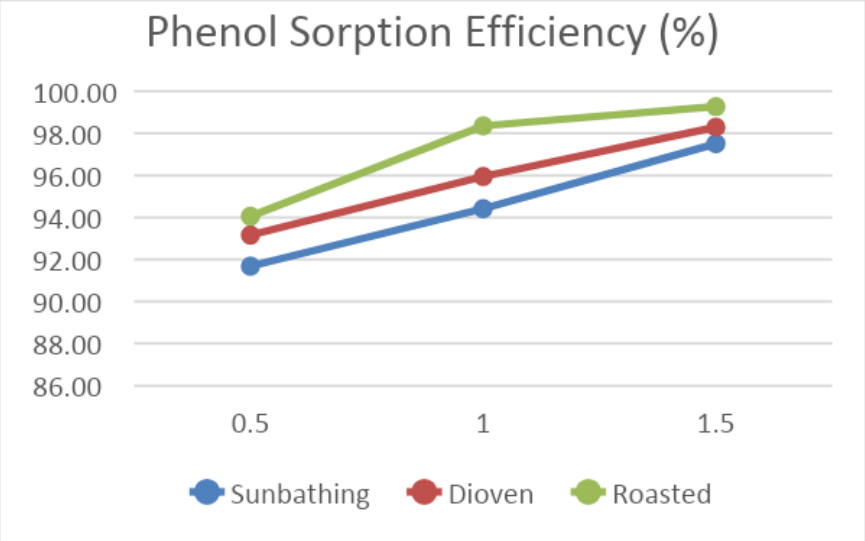

Figure 1. Phenol sorption efficiency

Description:
X: Mass of adsorbent (g)
Y: Absorption efficiency (%)

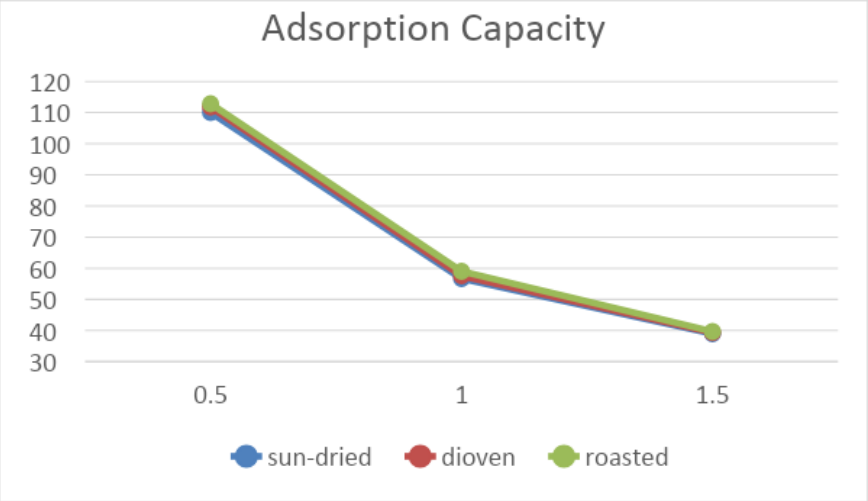

Figure 2. Adsorption Capacity

Description:
X: Mass of adsorbent (g)
Y: Adsorption capacity (mg/L)

In determining the moisture content of activated carbon derived from salak skin, measurements are taken before and after the activation process for each type of activated carbon material. The moisture content of salak skin-activated carbon is presented in Table 2.

Table 2. Moisture content of activated carbon Water Content

Water Content Before Activation (%)	**Water Content After Activation (%)**		
	Sun-dried	Oved-dried	Roasted
2.57	2.41	2.29	2.03

2. Effect of Variation of mass and Type of activated carbon material

Determination of the concentration of phenol that has been adsorbed using phenolic waste simulations with mass variations in each type of activated carbon material. Here a phenol concentration of 300 ppm. Table 3.3 presents data on the concentration of phenol that has been adsorbed by salak skin-activated carbon.

Table 3. Phenol Adsorption on Salak Bark Carbon

No.	**Sample (g)**	**Absorbance**	**Absorbed Concentration (mg/L)**	**Final Concentration (mg/L)**
1.	Sun-dried Carbon 0.5	1.1362	275.3	24.97
2.	Sun-dried Carbon 1.0	0.7622	283.25	16.75
3.	Sun-dried Carbon 1.5	0.3392	292.55	7.45
4.	Oven-dried Carbon 0.5	0.9332	279.49	20.51
5.	Oven-dried	0.5531	287.84	12.1

	Carbon 1.0			6
6.	Oven-dried Carbon1.5	0.2319	294.91	5.09
7.	Roasted carbon 0.5	0.6432	282.19	17.81
8.	Roasted carbon 1.0	0.2234	295.1	4.9
9.	Roasted Carbon 1.5	0.0981	297.85	2.15

Based on Table 3, a comparison graph illustrating the phenol concentration adsorbed by salak skin-activated carbon is shown in Figure 3. 3.

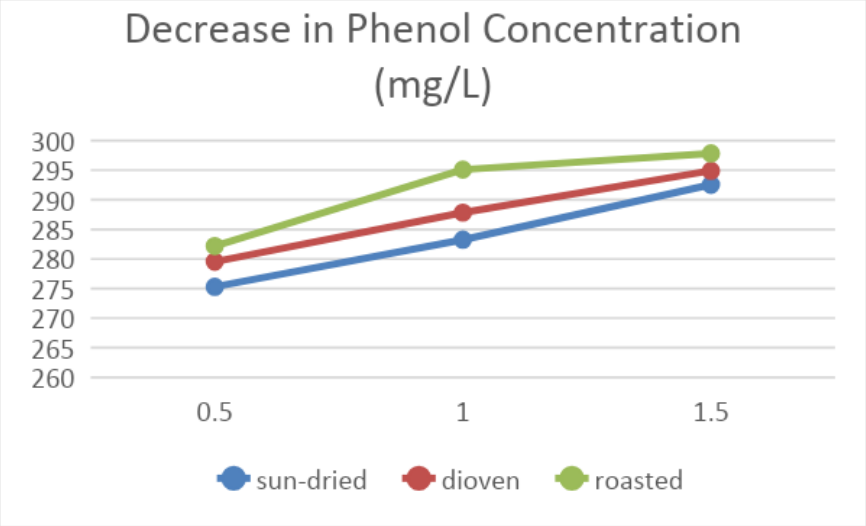

Figure 3. Decrease in Phenol Concentration

Description:
X: Mass of adsorbent (g)
Y: Concentration of phenol adsorbed (mg/L)

3. Discussion

a) Adsorption Capacity of Salak Bark Activated Carbon

The method employed to reduce phenol concentration is adsorption, which is not only straightforward but also highly effective and cost-efficient. In the adsorption process, activated carbon produced through various methods using $ZnCl_2$, as an activator is mixed with simulated phenolic waste at a concentration of 300 ppm.In this study, phenol is chosen as the adsorbate due to its hazardous nature; phenolic waste is commonly generated by both small and large industries. The next step involves stirring the mixture for one hour, followed by filtration to separate the filtrate from the residue. The resulting filtrate is subsequently analyzed using a UV-Vis spectrophotometer (Dwi Putranto, et al). In the research conducted, there are several fixed variables consisting of the type of activator used, the initial concentration of adsorbate, stirrer time and chemical activation, and PH activator. The independent variables are the type of treatment of activated carbon material and the mass of adsorbent that is varied.

Based on the research results shown in figure 1, it was found that the variation of activated carbon treatment and adsorbent mass in its ability to adsorb phenol. This graph shows that each type of activated carbon treatment has the effectiveness of reducing the

concentration of phenol. The adsorbent that has the greatest effectiveness in reducing phenol concentration is carbon with roasted treatment, which results in a final concentration of phenol adsorbed of 2.15 mg/L with a capacitance value of 297.85 mg/L with a mass of 1.5 g activated carbon. It shows that as the mass of the adsorbent increases, there is a corresponding decrease in concentration for each type of activated carbon. A greater adsorbent mass enhances the adsorption capacity, as this increases the total surface area and the number of pores available to bind the adsorbate during the adsorption process (Gilar Pambayun, et al).

Percent removal refers to the amount of phenol concentration absorbed by activated carbon relative to the initial phenolconcentration, while adsorption capacity indicates the amount of adsorbate that can be adsorbed per gram of activated carbon. The results of this study show that the activated carbon material with the highest absorption efficiency is the roasted variety, achieving a removal rate of 99.28% with an adsorbent mass of 1.5 g. Conversely, its adsorption capacity is only 39.71 mg/g at the same mass.

b) Effect of Mass Variation and Type of Activated Carbon Material

Figure 2 shows the absorption efficiency of salak skin-activated carbon with various treatments (in the sun, roasted, and in the oven) and also the amount of adsorbent mass. It can be seen from the graph that each variation of activated carbon treatment shows an increase in the percentage of adsorption along with the increase in adsorbent mass however, the results also indicate that the adsorption capacity decreases with increasing adsorbent mass. This trend occurs because, while the adsorbent mass increases the percentage of adsorption efficiency, it simultaneously leads to a dilution effect on the adsorption capacity (Nurhasni, et al).

One of the chemical properties that affects the quality of activated carbon is water content. Testing the water content is done by heating the activated carbon in the ovenat 105^0 C for one hour, and then weighing until a constant weight is achieved (Ari Budiono, et al). Based on Table 4.2, it is observed that the water content of salak skin carbon decreases after activation. The water content before activation is 2.57%. After activation, the water content of salak peel carbon is measured at 2.41% for sun-dried, 2.29% for oven-dried, and 2.03% for roasted samples.

The moisture content produced from this study meets the quality standards for activated carbon as outlined in SII 0258-88, which stipulates a maximum of 15% for powdered activated carbon (Azhary, et al). Overall, the moisture content observed in this study is relatively low, indicating that the water bound to the raw material is released during the carbonization process before activation. Thedecrease in water content is closely linked to the hygroscopic properties of the activator. The binding of water molecules by the activator enlarges the pores in the activated. Larger pores contribute to an increased surface area, which enhances the adsorption capacity of the activated carbon. Consequently, an increase in adsorption ability signifies better quality of the activated carbon (Pambayun, et al).

The results and discussion should be presented in the same part, clearly and briefly. The discussion part should contain the benefit of the research result, not the repeat result part. The results and discussion part can be written in the same part to avoid the extensive quotation. Tables or graphs must present different results. The results of data analysis must be reliable in answering research problems. References to the discussion should not repeat the references in the introduction. Comparisons to the findings of previous studies must be included.

CONCLUSION

The most effective type of adsorbent in reducing the concentration of phenol is adsorbent with roasted treatment, which obtained the final phenol concentration of 2.15 mg/L with a large concentration absorbed 297.85 mg/L at a mass of activated carbon 1.5g. So it can be concluded that all variations of activated carbon treatment will experience a decrease in the

absorption of phenol concentration along with the increase in adsorbent mass. The more adsorbent mass will increase the ability of adsorbs to phenol.

Each type of adsorbent will experience an increase in the percentage of removal as the mass of the adsorbent increases. It can be seen from the results of this study that the adsorb capacity value will decrease with increasing adsorbent mass. This happens because the increasing mass of adsorbent will also increase the percentage value of adsorption efficiency and the adsorption capacity of each type of adsorbent.

SUGGESTION

This research is expected to be a reference in activated carbon research that utilizes unused biomass. The variations in this study are the treatment in the preparation of biomass and the type of activator ZnCl2 used and then tested the adsorbs power of this salak skin activated carbon against phenol reduction.

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