

7. Effectiveness of Waste Shrimp Shell as Chitosan Polymer Medium (CPM) Mask In Reducing Cigarette Smoke

by Aussie Amalia

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Effectiveness of Waste Shrimp Shell as Chitosan Polymer Medium (CPM) Mask In Reducing Cigarette Smoke

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Hafidya Norista Pramesti, Yayok Suryo Purnomo*, Aussie Amalia, Tuhu Agung Rachmanto, Okik Hendriyanto Cahyonugroho

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Department of Environmental Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya 60294, Indonesia

*Corresponding author:
E-mail:
yayoksp.tl@upnjatim.ac.id

ABSTRACT

1
Shrimp shell waste contains chitin which is considered potential as a mask coating material to remove toxic substances in cigarette smoke. The masks were made using Chitosan Polymer Medium (CPM) with the spray coating method. Therefore, this study aims to determine the optimal concentration of reducing nicotine, constant, and reduced capacity of Chitosan Polymer Medium (CPM). The variations used were the type of CPM, the total spraying as 3 sprays, 5 sprays, and 7 sprays, and the concentration of CPM was 10,000 ppm, 20,000 ppm, 30,000 ppm, 40,000 ppm, and 50,000 ppm. The best result is the nicotine removal percentage is 99.98%, and the adsorption capacity is 7,0376 mg/g. The results showed that shrimp shell CPM was effective as an adsorbent in the adsorption process to remove nicotine in cigarette smoke.

Keywords: Shrimp shell waste, Chitosan Polymer Medium (CPM), mask, nicotine

Introduction

Over the past ten years, men have dominated tobacco usage, ranking Indonesia among the nations with the highest tobacco use rates worldwide (Farihah et al., 2021). Because the compounds breathed are 4–6 times higher than those inhaled by active smokers, exposure to secondhand smoke may have a severe effect (Umar & Rachmiyani, 2021).

Nicotine (β -pyridil—N-methyl pyrrolidine), an organic chemical molecule that is a member of the alkaloid family, is present in cigarettes in hazardous amounts (Alegantina, 2018). This compound is produced naturally in a variety of plants. Nicotine is found in *Nicotiana tabacum*, *Nicotiana glauca*, and other species or their synthetics are addictive and can lead to addiction (Novitasari, 2017). The risk of exposure to cigarette smoke if inhaled can cause severe irritation of the respiratory tract, and symptoms caused by headache, dizziness, nausea, shortness of breath, cough and insomnia (Mardani, 2015). Among other things, smoking has risks that can promote the growth of cancer (Schaal & Chellappan, 2014) and lung cancer development brought on by the CYP2B6 genetic variant (Wassenaar et al., 2013). In the liver, CYP2A6, UDP-glucuronosyltransferase, and flavin-containing monooxygenase metabolize more than 80% of the ingested nicotine (Alegantina, 2018). According to Government Regulation of the Republic of Indonesia Number 109 (2011), as much as 85-90% of nicotine is metabolized before elimination through renal excretion.

Hazards that have been identified require several control measures to a point of safety. The way that can be used to control the dangers of cigarette smoke is to use a mask. Masks can be used as an antidote to harmful substances in cigarette smoke that enter the body (Wahyuni & Kurniawati, 2021). In addition, the effectiveness of masks in preventing inhalation of Particulate Matter (PM) has been successfully tested and previous studies have shown that there are immediate positive results on blood pressure and heart rate (Hansstein & Echeagaray, 2018).

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Chitosan is a polysaccharide polymer widely distributed in nature as an exoskeleton in shrimp, crab, lobster, and insects with the second most abundant amount after cellulose. (Pradita, 2016). The content of chitin in shrimp shells reaches 42%-57% (Dali et al., 2016). Chitosan contains a large number of amino and hydroxyl groups, which has the advantages of good adsorption, regeneration, and environmental protection (Yi et al., 2020). One of the derivative forms of chitosan is Chitosan Polymer Medium (CPM), which is chitosan with a smaller polymer size compared to large polymer chitosan. The manufacture of CPM comes from powdered chitosan which is dissolved using acetic acid and aquadest, then sizing is done using a magnetic stirrer so that the chitosan polymer becomes shorter (Mardani, 2015).

Based on the description of the problems above, it is very necessary to do further research on reducing the effect of exposure to cigarette smoke on passive smokers using modified masks and utilizing crab shell waste which has high chitin content as Chitosan Polymer Medium (CPM). The analysis used is Gas Chromatography Mass Spectrometry (GCMS) to test the adsorption gas content and functional groups (Wahyudi et al., 2020). So, the researchers took the initiative to conduct research on Effectiveness of Waste Shrimp Shell as Chitosan Polymer Medium (CPM) Mask in Reducing Cigarette Smoke.

Material and Methods

Main research

The first research is the preparation and manufacture of chitosan. This stage of making chitosan includes several processes starting from the preparation of tools, and the preparation of raw materials to changing its physical characteristics into chitosan which is commonly found (commercial). Shrimp shells as raw material for making chitosan are first to cut into small pieces, after that the raw materials are dried in the sun for 3 x 24 hours to reduce the water content of the raw materials until the weight of crab shells and shrimp shells is constant and there is no decrease. After the preparation process is complete, the next process is tool preparation. The tool used in the process of making chitosan is a grinder. Next, is the filtering process using an 80 mesh filter, to produce powdered chitosan.

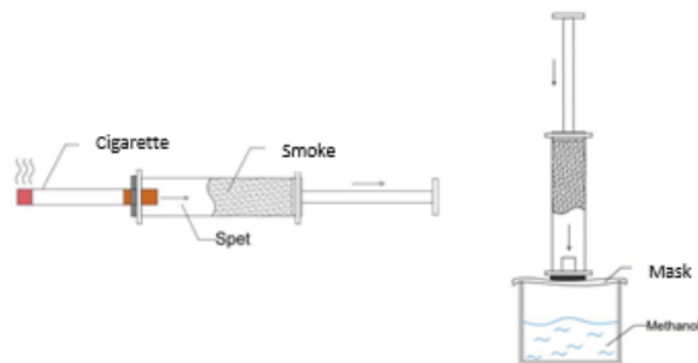


Figure 1. The performance model of the CPM mask

The next research is the stage of making Chitosan Polymer Medium (CPM) 5 grams of chitosan dissolved in 100 mL of 1% acetic acid plus distilled water up to 500 mL by sizing using a magnetic stirrer for 1 hour cutting the chitosan polymer to be shorter. The next process is precipitation with the addition of 100 mL NaOH 3N, followed by neutralization with distilled water, drying of CPM is done using oven. CPM solutions are also prepared at concentrations of 10,000 ppm, 20,000 ppm, 30,000 ppm, 40,000 ppm, and 50,000 ppm. This treatment was used to determine the effect of

chitosan concentration in absorbing nicotine in cigarette smoke. The performance process of the CPM mask begins with placing a cloth mask that has received CPM spraying treatment, then inserting a cigarette that has been burned with 14.4 mg of nicotine contained in 6 cigarettes. Cigarette smoke will pass through the mask and will be accommodated in a chamber containing a methanol solution. Cigarette smoke gas in the chamber is then detected using mass spectrometry gas chromatography. The following is the performance model of the CPM mask in Figure 1.

Results and Discussion

Nicotine removal effectiveness

In this study, a comparison was made between three variations of spraying, namely 3 sprays, 5 sprays, and 7 sprays. Each spraying variation contained variations in concentration, namely concentrations of 10,000 ppm, 20,000 ppm, 30,000 ppm, 40,000 ppm, and 50,000 ppm. The effect of concentration can be known by comparing the percent removal to the variation of spraying. The results of the comparison of the effect of concentration on each type of Chitosan Polymer Medium (CPM) can be known by comparing the percent removal to the variation of spraying. Figure 2 is the result of a graph of the relationship between the concentration of CPM shrimp shells with the percent removal of nicotine and variations in spraying.

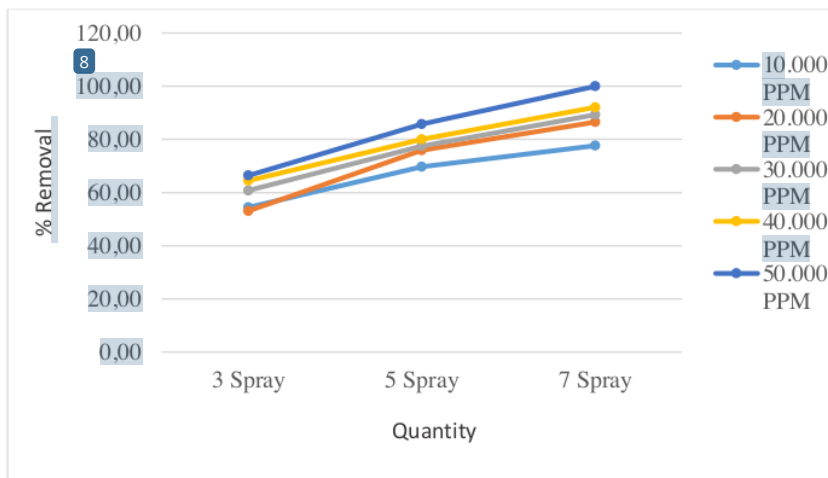


Figure 2. The relationship between percent nicotine removal and spray quantity at various concentrations of CPM shrimp shell

The more the total spray and the higher the concentration of CPM, the more nicotine will be adsorbed because there are more opportunities for CPM particles to come into contact with nicotine. This causes more and more nicotine to bind to the CPM pores.

The graph above describes the use of Chitosan Polymer Medium (CPM) for crab shells, Chitosan Polymer Medium (CPM) for shrimp shells, and Chitosan Polymer Medium (CPM) mixed with different total sprays and concentrations of CPM. Optimal nicotine removal results in the Chitosan Polymer Medium (CPM) crab shells were obtained with a total of 7 sprays and a concentration of 50,000 ppm with a nicotine removal of 80.73%. Optimal nicotine removal results in Chitosan Polymer Medium (CPM) shrimp shells were obtained with a total of 7 sprays and a concentration of 50,000 ppm with a nicotine removal of 99.98%. Meanwhile, the optimal nicotine removal results in mixed Chitosan Polymer Medium (CPM) were obtained with a total of 7 sprays and a concentration of 50,000 ppm with a nicotine removal of 89.28%.

The most optimum removal occurred in the type of Chitosan Polymer Medium (CPM) of shrimp shells because the value of the degree of deacetylation of shrimp shells was the largest and the number of pores on the surface of the CPM of shrimp shells was dense and denser. The allowance shows that the more mass of the adsorbent the more active sites that can bind the adsorbate.

In this study, the kinetics of the adsorption system that occurs on the mask is analyzed using the Thomas Model which is one of the most commonly used performance theory models. The formula used is (Blessing et al., 2020):

$$\ln \left[\frac{C_0}{C_t} - 1 \right] = \frac{K_{th} q_0 x}{Q} - K_{th} C_0 t \quad (1)$$

Descripti¹⁵

C_0 = Influent concentration (mg/L)

C_t = Relative concentration (mg/L)

K_{th} = Adsorption rate constant

q_0 = Trapping Capacity (mg/g)

Q = Air flow rate with a cigarette diameter of 7 mm so that the flow rate is 0.000023 (L/minute)

To calculate the adsorption capacity using Thomas model⁴, it is necessary to provide a linear regression calculation ($y = ax + b$). K_{th} and q_0 values are determined⁴ from the slope and intercept on the linear regression curve $\ln (C_t/C_0 - 1)$ (Pramesti et al., 2020). The values for K_{th} and q_0 are determined from the slope and intercept on the linear line⁴ lot, namely $\ln((C_0/C_t) - 1)$ against the research time (t). So we get the derivative formula to get the values of K_{th} and q_0 as follows:

$$K_{th} = \frac{\text{slope}}{C_0} \quad (2)$$

$$q_0 = \frac{\text{intersep}}{(x/Q) \times K_{th}} \quad (3)$$

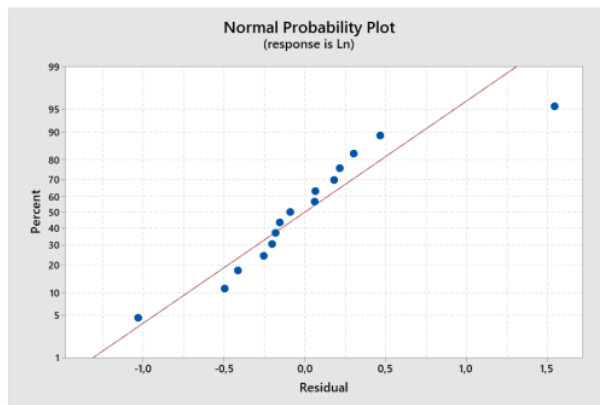


Figure 3. Graph of nicotine adsorption capacity with Chitosan Polymer Medium (CPM) shrimp shell

Calculation of linear regression ($y = ax + b$) on the sample Chitosan Polymer Medium (CPM) shrimp shells obtained the results $y = -0.03161x + 4.173$. With the coefficient of determination (R^2) obtained from the experimental results of 66.97% and the resulting residual point has approached a straight line, the residual is said to have followed a normal distribution. The results of the effect of different types of CPM on the results of the Kth and q0 values in the Thomas Model are in Table 1.

Table 1. The effect of different types of CPM on the results of Kth and q0 values in the Thomas Model

CPM	Linier Equation	R ²	Kth	q0
Shrimp shell	-0,03161x + 4,173	66,97	0,0007	7,0376 4,2226 3,0161

Source: Analysis Results, 2022

The values of the constants Kth and q0 can be known through the slope and intercept values from the equation shown in Figure 3. Based on these equations, the constant values are shown in Table 1. Where, the Thomas constant obtained is inversely proportional to the adsorption capacity of each adsorbent. This is in accordance with the Thomas equation which has been applied in this study which shows that the adsorption capacity is inversely proportional to the resulting capacity.

Table 1. shows the calculation results of Thomas's equation, the highest adsorption capacity for nicotine absorption is obtained in the Chitosan Polymer Medium (CPM) type, which is 7.0376 mg/g. Which means that 1 gram of Chitosan Polymer Medium (CPM) is able to absorb (q0) pollutant absorption in 7.0376 mg. The purpose of finding q0 in Thomas's modeling is to find out how much pollutant is absorbed against 1 gram of adsorbent that absorbs.

Conclusion

The best removal was obtained from the highest total spray variation and the highest concentration on Chitosan Polymer Medium (CPM) skin shrimp, which is 0.01% with an allowance of 99.98%. The results of the application of the Thomas model showed that the best adsorption capacity of Chitosan Polymer Medium (CPM) was 7.0376 mg/g.

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