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# Improvement of aroma of Noni juice using activated carbon adsorption

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Activated carbon was the best adsorbent in the adsorption system. This is caused by activated carbon having a large surface area and high adsorption force so that it's utilization can be optimal. One of the uses of activated carbon in the beverage industry is as a medium to adsorb the unpleasant aroma in noni juice. Noni juice is a functional beverage product made from noni fruit. This study aims to determine the effect of the increasing concentration of activated carbon which is optimal in removing the unpleasant aroma in noni juice. This study was designed using a Randomized Block Design (RBD) with one factor, namely activated carbon concentration, with 5 level treatments namely 6%, 12%, 18%, 24%, and 30% b/v. Each treatment was repeated 3 times so that a combination of 15 treatments was obtained. The tested parameters were total phenolic and antioxidant activity, then the best treatment was selected for organoleptic testing using 8 trained respondents. The results showed optimal conditions obtained from the concentration of activated carbon as much as 18% with a total phenolic content of 2.440, the antioxidant activity of 352.6674 and organoleptic scores of 3.5. As much as 18% of activated carbon was added and it showed a quite low amount in the reduction of total phenolic and antioxidant activity in noni juice. Aside from that, the preference level for the product was known to be quite high compared to the product with the addition of activated carbon by 24%.

**Keywords: Activated Carbon; Adsorption; Aroma; Noni Juice.**

## INTRODUCTION

Activated carbon is one of the most effective media in the adsorption system. This is caused by activated carbon having a large surface area and high adsorption power so it can cope with a wide range of contaminants (De Gisi et.al., 2016). The activated carbon manufacturing industry in Indonesia has experienced considerable progress, increasing demand for both foreign and domestic markets due to the increasing number of activated carbon applications applied to the industry. The use of activated carbon is generally used in the pharmaceutical, food, beverage, water purification, pharmaceutical and chemical industries (Bortolini et.al., 2017).

Basically, the activated carbon can be made from all carbon-containing materials. However, the quality is very dependent on the material and manufacturing process. Activated carbon from the coconut shell as an activated carbon raw material on the basis of the quality produced is better than other materials (Danish and Ahmad, 2018). This is because activated carbon made from coconut shell has a high level of hardness so that it facilitates the handling characteristics, surface area above 1500 $m^2/g$, BET surface areas of ACs could be > 2000 $m^2/g$, depending on activation agents and activation (Ao et.al., 2018). Based on the research conducted by Bledzki et.al., (2010), the chemical composition of coconut shell is 34% of cellulose, 27% of lignin, and 21% of hemiselulose.

One of the uses of activated carbon in the beverage industry is as a medium to eliminate

unpleasant aroma in noni juice. Noni juice is a functional beverage product made from noni fruit. According to West et.al., (2018), the production of Noni fruit have developed very rapidly in the last few years. This is due to the empirical facts and scientific research evidence about the benefits of Noni fruit for health, namely to treat degenerative diseases such as cancer, tumors, and diabetes. The active compounds contained in Noni juice are very beneficial for the body, such as phenol compounds, organic acids, and alkaloid (West et.al., 2018). The problem faced in consuming Noni juice is the unpleasant aroma.

The unpleasant aroma of noni juice can be improved using adsorption techniques with activated carbon. The unpleasant aroma of noni juice can reduce the costumer acceptant. Therefore, further research is conducted on the adsorption of aroma in noni juice using activated carbon, as well as the total content of phenol or antioxidants in noni juice. The application of activated carbon in reducing the aroma of noni juice is expected to increase the value of the *organoleptic juice* in question so that the level of acceptance of the product will increase.

## MATERIALS AND METHODS

### Materials

The main materials used in this study are activated carbon and noni juice which have been on the market. Other materials used for adsorption were aqua destillata, while the material used for the analysis of *total phenolic Content* (TPC) using a spectrophotometer was 10% Folin-Ciocalteu reagent, 7.5% Sodium carbonate, and gallic acid standard. Other ingredients used for antioxidant testing are methanol, DPPH solution, aquades, and vitamin C.

### Methods

The research used Randomized Block Design (RBD) consisting of 1 factor with 5 levels of treatment and each treatment repeated 3 times so that 15 experimental units were obtained.

### The adsorption process of noni juice

Activated carbon is prepared as much as 6%, 12%, 18%, 24%, and 30% b/v. The noni juice used is the one which has been distributed in the market then diluted using distilled water to become a 40% noni juice solution. The adsorption process is done by mixing the noni juice solution and activated carbon at a temperature of 40-50$^0$C for 3-4 minutes, then filtered and obtained from the adsorption noni juice solution. The flowchart of noni juice adsorption process can be seen in Figure 1.

### Total Phenol Analysis

The analysis of total phenolic content was carried out by Spectrophotometry method using UV-Vis Spectrophotometer. The testing of total phenolic was carried out in accordance with the modified procedure Al Amri et.al., (2018). The Manufacture of Gallic Acid Standard curve:

1.Gallic acid powder weighed as much as 0.01 gram.
2.Filled into a 100 ml volumetric flask and distilled water was added to the boundary mark.
3.Solution was homogenized so that the gallic acid mother solution was obtained at 100 ppm.
4.The solution was diluted with a concentration of 0 ppm, 20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm.
5.Each concentration was taken 0.5 ml and 2.5 ml of 10% Folin-Ciocalteu reagent was added.
6.The solution was homogenized and incubated for 5 minutes in the dark.
7..Added 2 ml of $Na_2CO_3$ 7.5% to the solution.
8.Homogenized and incubated for 30 minutes in the dark.
9..Absorbance measured with a wavelength of 765 nm.
10.The results of absorbance measurements plotted into curves with x were concentrations of gallic acid and Y was the absorbance to obtain a regression formula of Y = ax + b

Preparation of Test Solutions (Samples):

A total of 1.0 mL samples were added with 5.0 mL of Folin-Ciocalteu reagent which was diluted with water (1:10 v/v) and 4.0 mL $Na_2CO_3$ 1M. After incubation for 60 minutes, the absorbance was measured at a wavelength of 765 nm. As a standard, the raw curve of gallic acid was made with a concentration series of 20, 40, 60, 80, 100 ppm. The total phenolic content is expressed in mg equivalent of gallic acid/ml extract. The number of compounds was phenolic measured based on the standard curve of *Gallic acid* (gallic acid) and expressed as mg Gallic Acid Equivalent (GAE)/g extract.

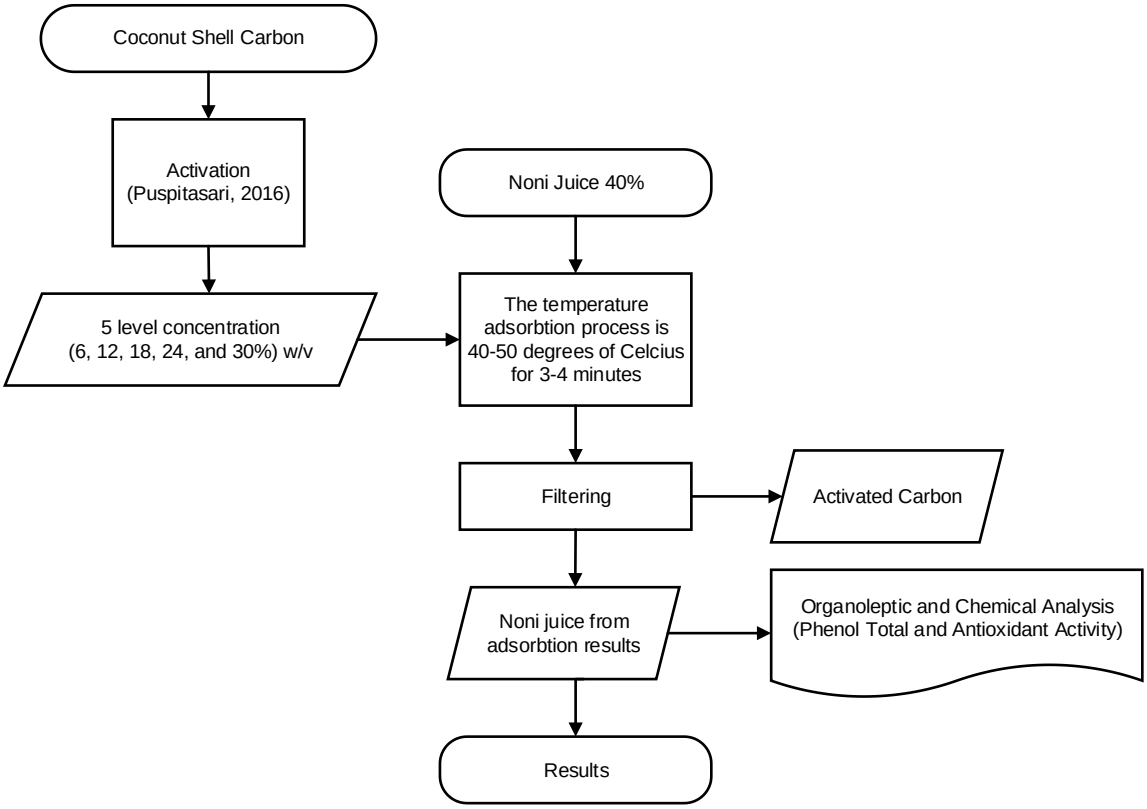


**Figure 1. Flowchart of Noni juice adsorption process**

The level of phenolic compounds in the extracts was calculated by the following equation:

$$C = \frac{c \times fp \times V}{m} \quad (1)$$

Where;
C = concentration of TPC (mg GAE/g extract)
c = concentration of gallic acid (µg GAE/mL)
V = Volume of extract solution taken for testing (ml)
m = weight of extract used for testing (g)

**Antioxidant Activity Analysis**

Polyphenol compounds have strong antioxidant activity and useful against free radical molecules that cause heart disease. Therefore, it is necessary to test the antioxidant activity in the extract obtained. Analysis of antioxidant activity was carried out with the DPPH method with the following procedure (Bramorski et.al., 2010):
1-0.1 g of Noni juice was dissolved with 100 ml of distilled water in a measuring flask.
2-The mother liquor was 3 ml; 4 ml; and 5 ml, pipetted into a 50 ml volumetric flask to get a concentration of 60, 80, 100 ppm.
3-Samples at each concentration were taken 5 ml and put into a test tube. Then in each test tube, 2.5 ml of DPPH was added.
4-The control solution was made by means of a 2.5 ml DPPH solution then put into 5 ml of distilled water.
5-DPPH absorbance was measured by visible spectrophotometry at a wavelength of 517 nm. The antioxidant ability was measured as a decrease in adsorption of DPPH solution due to the addition of samples.
6-The uptake value of DPPH solution before and after the addition of extracts was calculated as percent inhibition (% inhibition) with the following formula:

$$\% \ Inhibition = \frac{A\ control - A\ sample}{A\ control} \ x\ 100\% \quad (2)$$

7-Furthermore the results were included in the linear regression equation using the formula of Y = aX + b, where Y is percent inhibition, and X is concentration. This equation was used to determine the $IC_{50}$ from each sample.

## RESULTS AND DISCUSSION

### Total Phenolic Content

Based on the results of variance analysis (ANOVA) showed that the addition of activated carbon adsorbent did not have a significant effect on the total phenolic of noni juice, this is indicated by the value of *sig* > 0.05. The calculation results of total phenolic values of noni juice based on the addition of activated carbon adsorbent can be seen in Table 1**.**

**Table 1. Calculation results of total phenolic values of noni juice based on the addition of activated carbon adsorbent**

| Adsorbsent concentration | Total Phenolic (mgGAE/ml extract) |
|---|---|
| 6% | 2,572 |
| 12% | 2,527 |
| 18% | 2,440 |
| 24% | 2,424 |
| 30% | 2,365 |

Noni juice which had the highest total phenolic content was noni juice by adding an adsorbent of 6% b/v with a value of 2.572 mgGAE/ml of material, which means that each ml of noni juice contains total phenolic equivalent to 2.572 mg equivalent of gallic acid. 40% noni juice had the lowest total phenolic content, which was the noni juice with the addition of 12% b/v adsorbent with a value of 2.365 mgGAE/ml of material, which means that every 40% noni juice contains total phenolic equivalent to 2.365 mg gallic acid equivalent. According to Bramorski et.al., (2010) the total phenolic content of commercial noni juice was 91.90 ± 0.52 mgGAE/100mL of juice.

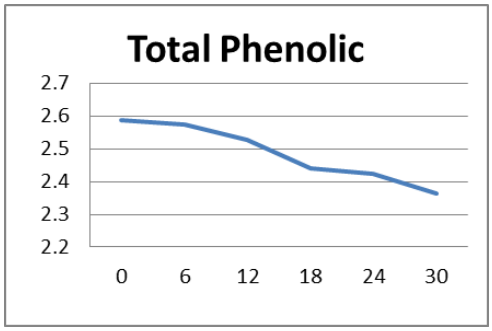


**Figure 2. Average Graphs of Total Phenolic Values in Noni Juice**

Figure 2. Showed a decrease in total phenolic content of noni juice. Hameed and Rahman (2008) states that the efficiency of decreasing the adsorbed phenol is also influenced by contact time. Prolonged contact time will maximize the adsorbent adsorption into the adsorbent which can cause an increase in the efficiency value of decreasing phenolic content. In addition, an increase in temperature causes a decrease in the activated adsorption capacity of phenols (Kadir et.al., 2011)

According to Blanco etal., (2006), Noni is one of the medicinal plants which has more than 160 phytochemical components that have been identified and most of them are phenol compounds, organic acids and alkaloids. Phenolic compounds that have been reported include anthraquinones (damnacanthal, morindone, morindin, etc.). The main organic compounds include caproic acid and caprylic acid.

### Antioxidant activity ($IC_{50}$)

The analysis of variance (ANOVA) results showed that the addition of activated carbon had a significant effect on antioxidant activity ($IC_{50}$). This was indicated by a value of *sig* less than 0.05, so the BNJ continued to do further testing (Real Difference Honest) on the concentration of activated carbon. The calculation results of IC values$_{50}$ on noni juice studied can be seen in Table 2.

**Table 2. Value of Antioxidant Activity Based on the addition of Adsorbent**

| Adsorbsent concentration | $IC_{50}$ Value (ppm) |
|---|---|
| 6% | 328,0942 |
| 12% | 333,4156 |
| 18% | 352,6674 |
| 24% | 364,527 |
| 30% | 373,2772 |

Noni juice with the highest average value of $IC_{50}$ was juice with the weakest antioxidant activity ability, namely noni juice with the addition of 30% activated carbon adsorbent with ICvalue$_{50}$ of 373,2772 ppm which means that each concentration of 373,2772 ppm was able to reduce free radicals by 50%. Noni juice with the highest average $IC_{50\ value}$ was juice with the strongest antioxidant activity ability, namely noni juice with the addition of 6% activated carbon adsorbent with ICvalue$_{50}$ of 328.0942 ppm which means that each concentration of 328.0942 ppm was capable to reduce free radicals by 50%. According to Bramorski et.al., (2010) the content of antioxidant activity in commercial noni juice was 5.85 ± 2.24 mmol/L juice.

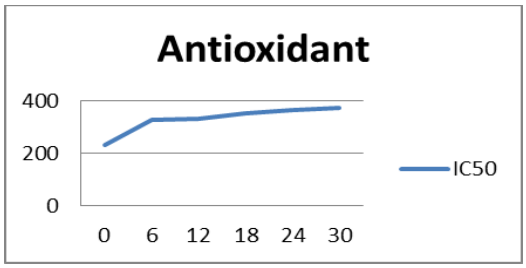


**Figure 3. Average Graph of Antioxidant Value of Noni Juice**

Factors that can affect the content level of antioxidant compounds (*anthocyanin*) was the storage in cold temperatures for a long time. They became one of the causes of decreasing levels of phenolic compounds and vitamins contained in fruits (Turkben et.al., 2010). In addition, according to Dąbrowski et.al., (2005) activated carbon has the ability to adsorb phenol compounds, this is also supported by the pH of the adsorbate which tends to be low. Phenol is a compound that has a hydroxyl group attached to an aromatic ring. According to Pellegrini et al.,(2003), phenol compounds have strong antioxidant properties.

**Organoleptic Test**

Based on the Friedman test results showed that the addition of activated carbon adsorbent to noni juice did not have a significant effect on organoleptic juice. This was indicated by the value of sig greater than 0.05, which was 0.683. The organoleptic score of Noni juice with the addition of activated carbon adsorbent can be seen in Table 3.

**Table 3 Average Organoleptic Score of Noni Juice with the addition of activated carbon adsorbents**

| Code | Aroma | Flavor |
|---|---|---|
| **MKNM (6%)** | 2,875 | 2,625 |
| **MKDB (12%)** | 3 | 2,875 |
| **MKLB (18%)** | 3,125 | 3,875 |
| **MKDE (24%)** | 3,5 | 3,25 |
| **MKTP (30%)** | 4,625 | 4,125 |

It can be seen that the highest average score in aroma criteria were found in the MKTP code (30%) of 4,625 and the lowest average score was in the MKNM code (6%) of 2,875. The results of the organoleptic assessment from each panelist were different because the panelist assessment of the aroma for a product is very subjective. The highest average taste criteria was found in the MKTP code (30%) of 4,125 and the lowest average score was in the MKNM code (6%) of 2,625.

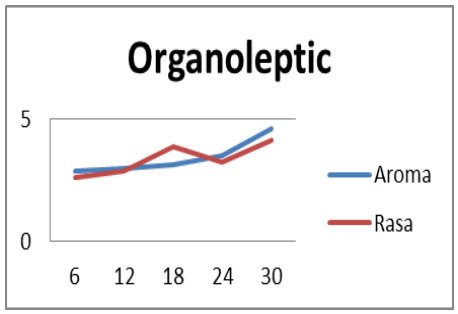


**Figure 4. Average Graph of Noni Juice Organoleptic Value**

Figure 4 showed that the higher the addition of activated carbon adsorbent, the lower the unpleasant aroma of noni juice. In addition, the preference level for the product was increased. The decrease in the unpleasant aroma in noni juice was thought to be due to the increasing number of activated carbon, causing greater pore size and also the increased surface area of activated carbon which increased the higher the adsorption capacity of activated carbon. The unpleasant aroma of noni juice can be lost because of the selective process on activated carbon. According to Bansal (2005), the adsorption is a process that occurs when a liquid or gas, bound to a solid or liquid and finally forms a thin layer or film on its surface. The unpleasant aroma particles in Noni juice will be entangled on the surface of the activated carbon.

**FTIR Test Results**

FTIR is an instrument that uses the spectroscopic principle of infrared spectrophotics equipped with Fourier transformation for detection and analysis of the results of the spectrum. The usefulness of the FTIR test is to identify organic compounds in a material (Amir, 2011). In this research, the FTIR test was conducted to identify saponin compounds in noni fruit juice after and before the activated carbon adsorbent was added. The FTIR test results can be seen in Figure 5 and Figure 6.

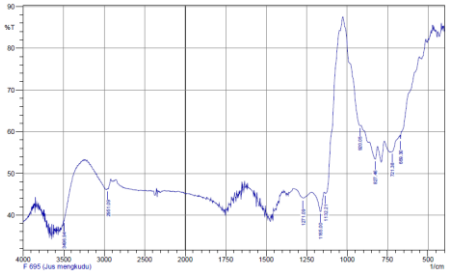

**Figure 5. FTIR Test Results of Noni juice Before the Addition of Adsorbent**

Based on Figure 4, noni juice appears to peak at the wave number of 2850-2970 $cm^{-1}$ which probably indicates the presence of C-H Alkane groups which usually appear in wave number of 2850-2970 and 1340-1470 $cm^{-1}$. A peak at the wave number of 1050-1300 $cm^{-1}$ shows an indication of CO alcohol/ether/carboxylic acid/ester group which usually appears on the wave number. A peak at the wave number of 690-900 $cm^{-1}$ shows for the AP sample which might indicate the presence of an aromatic CH group which usually appears at waves 690-900 $cm^{-1}$ and 3010-3100 $cm^{-1}$. The peak in the range wave of 675-995 $cm^{-1}$ for AP samples which might indicate the presence of CH Alkene groups which usually appear at wave numbers 675-995 and 3010-3095 $cm^{-1}$.

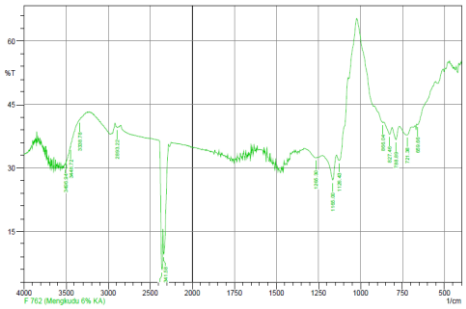

**Figure 6. FTIR Test Results of Noni juice with 6% Activated Carbon**

Based on the FTIR test results on noni juice with the addition of 6% activated carbon a peak at wave 690-900 $cm^{-1}$ appears which might indicate the presence of a CH aromatic ring that usually appears on wave numbers 690-900 $cm^{-1}$ and 3010-3100 $cm^{-1}$. A peak at the wave number of 675-995 $cm^{-1}$ appears which is likely to indicate the presence of CH Alkene groups which usually appear at wave numbers of 675-995 $cm^{-1}$ and 3010-3095 $cm^{-1}$. A peak at the wave number 1050-1300 $cm^{-1}$ appears that might indicate the presence of a CO alcohol/ether/ carboxylic acid/ester group which usually appears on the wave number.

## CONCLUSION

Based on the results of the study it can be concluded that the addition of activated carbon adsorbent does not have a significant effect on the total phenolic of noni juice, while the addition of activated carbon has a significant effect on antioxidant activity ($IC_{50}$). This is certainly different from the effect of adding activated carbon adsorbent to noni juice which does not have a significant effect on organoleptic noni juice. The addition of 18% activated carbon is known as the best treatment because the level of phenol and antioxidant reduction is quite low and the organoleptic score is quite high compared to the others.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

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## AUTHOR CONTRIBUTIONS

SW designed the experiment, control the progress and problem solving related to experiment, and correspondence. NLR control the progress of experiment and reviewed. HM performed all experiments and data analysis. All authors read and approved the final version.



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