Glucose syrup clarification with a different form of activated charcoal

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Abstract. Glucose produced by enzymatic hydrolysis still has a low purity level that is not meet the quality of glucose syrup as standardized by the Indonesian national standard (SNI). This study aimed to know the effect of the activated charcoal form on the purification of glucose syrup. The method used in this study is refining, in which 1% of activated charcoal was used (powder or granulated activated charcoal). Parameters observed were reducing sugar, sweetness level, and clarity level. The results obtained in this study indicate that glucose syrup refined with powder activated charcoal has a higher value in all parameters observed. The hypothesis that powder form of activated charcoal has a better absorbing capacity is accepted.

1. Introduction
Glucose is a simple sugar that can be obtained from hydrolysis of starch. Starch hydrolysis can be done with acids, alkali as well as enzymes. In this study, we preferred to use the glucose syrup produced with enzymatic hydrolysis as it is more environmentally friendly due to less energy used and less by-product. Nevertheless, glucose produced by enzymatic hydrolysis still has a low purity level that is not meet the quality of glucose syrup as standardized by the Indonesian national standard (SNI).

To meet SNI standards, purification is needed to separate glucose syrup from non-glucose components so that glucose syrup obtained has a better quality. Various methods have been used to refine glucose syrup, but some have not met industry standards because prices are not yet applicable or not practical made it is necessary to find applicable and efficient methods of clarification.

Activated charcoal has been used for water purification and was found to be able to bind components that cause turbidity in water. Because the condition of glucose syrup is also liquid and the same properties as water, the activated charcoal is also considered capable of supporting glucose syrup for better quality. Purification was expected to eliminate compounds that cause turbidity. The active charcoal used for purification was 1% of the substrate [1].

The active charcoal that can be found at affordable prices was coconut shell activated charcoal. There are various forms of shell charcoal on the market, such as powder and granules. The powder has a broader surface; thus we hypothesized that powder activated charcoal should bind non-glucose components better than granulated activated charcoal that further will affect the purity of the glucose syrup.

Therefore in this study, we would like to know the effect of the activated charcoal form on the purification of glucose syrup. Furthermore, we would like to confirm that the hypothesis mentioned in the previous paragraph was acceptable.
2. Methods

2.1. Materials
The glucose syrup in this research was a crude syrup which was processed with the enzymatic method with two steps namely liquefaction and saccharification that exploited enzymes namely α amylase, pullulanase, and amyloglucosidase. The powder and granulate activated charcoal and zeolite were purchased from the chemical store (Sumber Rejeki).

2.2. Glucose syrup refining
2 liter of glucose syrup was prepared and put in the 2 beaker glass with 1 liter for each glass. To each glass 1% of activated charcoal was added in which in one beaker glass was added powder activated charcoal and to another glass was added granulate activated charcoal. Then it was heated to 70-80°C for 30 minutes. Then the syrup was transferred to the filtration tube (20 cm zeolite, 20 cm rough sand, and 40 cm fine sand). The glucose syrup after filtration then analyzed.

2.3. Observation Parameters

2.3.1. Reducing sugar (g/L). Reducing sugar was analyzed using the method described by Apriyantono (1989) in which 1 ml of diluted sample was placed in the reaction tube, then to the sample was added dinitrosalicylic acid (DNS) then mixed gently [2]. Then it was put inside boiled water for 5 minutes followed by cooling in room temperature. The absorbance was then measured at 550 nm. Then the reducing sugar was calculated converting the absorbance to the standard curve. The standard curve was made from pure glucose diluted in demineralized water in concentration 0, 25, 50, 75, 100, 125, and 150 ppm. Then the standard curve was made by plotting the obtained absorbance from all mentioned concentration.

2.3.2. Sweetness level (°Brix). The sweetness level was measured using the method explained by Apriyantono (1989) using hand refractometer [2]. The sample was put in the surface of hand refractometer then the sweetness level displayed in the tool’s screen.

2.3.3. Clarity level (T). The spectrophotometer was used to measure the clarity level. In which the absorbance of the sample was measured in maximum wavelength that was thought to be the clearer visually. Then the absorbance was converted to transmittance (T) using the formula A=2-log T that further considered as the clarity level.

3. Results and Discussion

3.1. Reducing sugar
The value of reducing sugar indicates the amount of simple sugars contained in food. Simple sugars formed in glucose syrup indicates the effectiveness of the purification materials. The value of reducing sugar in this research was measured by the DNS method using a spectrophotometer. The results of the variance analysis showed that the type of activated charcoal showed no significant effect on the value of reducing sugars obtained (p> 0.05). The results of the Duncan test on activated charcoal showed that based on the value of reducing sugars the two active charcoal used was different from the control however there was no difference between glucose syrup purified with granular or powder activated charcoal. Reducing sugar value of glucose syrup is presented in figure 1.
3.2 Reducing sugar of glucose syrup before and after refining process with a different form of activated charcoal.

The results of the observations (see figure 1) show that all types of activated charcoal applied to affect increasing the value of reducing sugar from the purified glucose syrup. The absorption capability of activated charcoal is due to the properties characteristic as a material consisting of free carbon that can bind the surrounding components that are not soluble in water [3]. The bond that formed between the activated charcoal and element like long-chain carbohydrates in the sample created higher clarity of glucose syrup. It remained short-chain carbohydrates such as glucose, maltose, and so on.

3. 2. Sweetness level

The sweetness level is an important parameter in glucose syrup. The sweetness level shows the value of dissolved solids in glucose syrup. The total dissolved solids in glucose syrup showed the amount of simple water-soluble sugars found in syrup.

As can be seen from figure 4 that the glucose syrup refined with powder activated charcoal had a higher sweetness level value compared to that which refined with granulated activated charcoal. As the activated charcoal has carbon that binds the more complex component in glucose syrup and retained simple components like glucose and other component dissolved in water thus increase the sweetness level. The higher value obtained from the sample purified with powder activated charcoal was because the higher surface of powder compared to the granulated charcoal that increases its
adsorption capacity. This result is in line with a study conducted by Ou et al. that also compared granulate and powder activated charcoal in the purification of ferulic acid from sugarcane bagasse [4]. Though the sample was different we compared this study to their study as both studies used charcoal as a purifier.

3.3. Clarity level
Activated charcoal application in purification of sugar syrup had been reported since decades ago in few studies [5,6]. Purification of glucose syrup aims to obtain syrup with a clearer appearance and free ion compounds. The clarity level in this study was measured using a spectrophotometer at a maximum wavelength of 370 nm. The clearer the glucose syrup the lower the absorbance. In this study, the purification was done by utilizing activated charcoal in a different form.

The value obtained indicates that the clarity level obtained in all treatments were much higher than the control. The higher clarity level obtained from the glucose syrup purified with the powder form of activated charcoal. The clarity level of glucose syrup purified with a different form of charcoal can be seen in figure 3.

![Figure 3](image_url)

**Figure 3.** Clarity level of glucose syrup before and after refining process with a different form of activated charcoal.

From figure 3 we can see that clarity level in sample clarified with a different form of activated charcoal were both higher more than 50 times of the sample’s clarity. This result indicated that all form of activated charcoal applied were effective in enhancing the clarity of glucose syrup. However, from the figure, the higher clarity level of sample refined with powder activated charcoal (70.16T) indicated that the powder charcoal is more effective compared to the granulated form of charcoal in absorbing component caused turbidity to glucose syrup. The higher absorption capacity of powder activated carbon compared to granulate carbon also found by Hille and Den Ouden (2005) when studied the effectiveness of activated carbon in absorbing phytotoxic compound in plant germination [7].

4. Conclusion
The results obtained in this study indicate that glucose syrup refined with powder activated charcoal has a higher value in all parameters observed. The hypothesis that powder form of activated charcoal has a better absorbing capacity is accepted.

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