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Optimization of Pectin Extraction from Kepok Banana Peel (Musa Acuminata Balbisiana Colla) Using Natural Deep Eutectic Solvent (NADESs)

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A B S T R A C T (GEORGIA 10)

Kepok banana peel is an abundant waste used as the main ingredient in pectin extraction. The pectin contained in Kepok bananas is known to be at a fairly high level compared to other types of bananas. This study aimed to determine the water content, methoxyl content, equivalent weight, galacturonic acid, and pectin yield in the pectin extraction process using the NADESS solvent extraction method at various NADESs C molar ratios (1:4; 1:7; 1:12) and extraction temperatures (80°C, 90 °C, and 100°C). Based on the results obtained, the best extract is located at a ratio of 1:4 with a temperature of 90°C, with a moisture content of 99.8%, a methoxyl content of 2.79%, a yield of pectin of 5.81%, an equivalent weight of 5333.33, and a galacturonic acid content of 75.56%. While the test results show that the concentration of the given K:G solution affects the amount of pectin yield obtained in this extraction process,

INTRODUCTION (GEORGIA 12)

Banana peel, one of organic waste, are abundant in Indonesia reach to 8,741,147 tons in 2021 [1]. It demonstrates the enormous potential for organic waste caused by bananas in Indonesia.Kepok bananas are the most commonly used for media consumption and food processing[2].It means that the Banana's peel becomes potential waste in Indonesia. In the Banana's peel, there is some useful component that can be used in food, cosmetic, and health such as Pectin.

Heteropolysaccharides contain pectin, which is the main structural element of the major cell wall and middle lamella of higher plants [3], [4]. Banana peel from Kepok has 19% pectin [5]. Indonesia's need for pectin increased from 183,050 kg per year in 2007 to 240,792 kg per year in 2013. Utilizing waste is one solution to Indonesia's projected 1,320 tons/year pectin demand by 2020. Indonesia's need for pectin increased from 183,050 kg per year in 2007 to 240,792 kg per year in 2013. Utilizing waste is one way to fulfill the rising need for pectin in Indonesia, where the need is anticipated to reach 1,320 tons/year by 2020 [6]. Jellies and jams are regularly made with pectin in the food business[7]. In the pharmaceutical sector, pectin is typically used as a thickening, emulsifier, and suspending agent [8]. Despite the fact that pectin has a wide range of uses in the food and pharmaceutical industries, people have a negative opinion of it because solid acids are employed in its extraction [9], [10]. Because they are non-toxic and do not evaporate quickly at room temperature [11], NADESs are good extraction solvents. Additionally, depending on their component parts, the majority of NADESs are soluble in water [12].

When combined at the proper molar ratio, NADESs, a type of solvent that is a derivative of DES (Deep Eutectic Solvent), have a lower melting point than DES[13]. NADESs are made up of two or three organic constituent components that interact through hydrogen

bonds[14][15][16]. The purpose of this study was to ascertain the yield of pectin content in banana peels from Kepok utilizing NADESs solvent. With the examination of equivalent weight, methoxyl content, and galacturonic acid to produce good and much higher quality pectin, the study is altering the ratio of potassium carbonate to glycerol and variations in temperature offered in the process extraction.

METHODS (GEORGIA 12)

Materials

The materials is Kepok banana peel, distilled water, Choline Chlorine with a purity of 60%, lactic acid with a purity of 90%, 1M potassium carbonate, and Glycerol 98%. NADESs A solution made from Choline Chlorine and Glycerol 1:2 Molar, NADESs B solution made from Choline Chlorine and lactic acid 1:2 M, NaDESs C solution made from Potasisium carbonate and Glycerol with the concentraion variation 1:4, 1:7, and 1:12 M.

Treatment and Experiment

The Kepok Banana's peel was mashed and sieved in size 1 mm. Then it dried in the oven for 12 hours at 80 °C. The NADES solutions A, B, and C were created by the various variables. The variables changed in this study for potassium carbonate:glycerol (K:G) in NADESs C were molar concentration ratios (1:4, 1:7, and 1:12) and extraction temperature (80°C, 90°C, and 100°C) in NADESs C.

Pectin Extraction

Kepok banana peel flour is created during the raw material preparation process. It is combined with NADESs A in a 1:8 (w/v) ratio and continuously stirred at 40°C for one hour. Following that, the Kepok banana flour was suspended in deionized water for 10 minutes at 80°C, followed by five more repetitions. Banana peel pulp is the end product of the extraction, which is heated for 15 hours at 40°C in an oven.

After rehydrating to 68% moisture content with NADESs A extracted banana peel, NADESs B 1:8 (w/v) treatment was added. The extraction process is exactly the same as for NADESs A.

Before being treated with NADESs C 1:8 (w/v), banana peels extracted with NADESs B were rehydrated (68% moisture content). With salt temperatures of 80°C, 90°C, and 100°C, respectively, and molar ratios of 1:4, 1:7, and 1:12 for the solvents, the extraction procedure for NADESs C is the same as for NADESs B. After diluting the extraction findings to 50 ml, pectin was precipitated for 10 minutes with the addition of 70% alcohol. With the use of a vacuum pump and Whatman filter paper no. 41, the obtained pectin was filtered. The pectin was filtered and then dried for 15 hours at 40°C.

Sample Analysis

Pectin is identified by reducing the water content in an oven for 15 hours at 40°C. Then determine the equivalent weight content by titrating the NaCl and pectin solutions with 0.1 N NaOH solution, adding 0.2 N NaOH solution, and 0.2 HCl in 25 mL, and titrating again to determine the methoxyl content and again to determine the galacturonic acid.

RESULT AND DISCUSSION Raw Material Preparation

The study found that 200 grams of the total wet weight of 500 grams of kepok banana peels were in the form of dry kepok banana peel flour. The Banana's peels were powdered and sized into 1 mm of particle size. The water content of the banana peel is reduced by 60%. Figure 1 shows how Kepok banana peels are dried.

Figure 1. The drying process of Kepok banana peels.

Preparation of Solvents

NADESs A solvent should be explicit, have a pH of 6.5, and have a molarity ratio of 1:2. The results obtained when preparing the NADES A solution differed slightly from the references in the literature. It is indicated by the color difference in the solution, which is a slightly cloudy yellow. Because the choline chloride used has a concentration of 60%, the color change in this solution is caused by the purity factor of choline chloride. The NADES A and NADES B solutions are depicted in Figure 2.

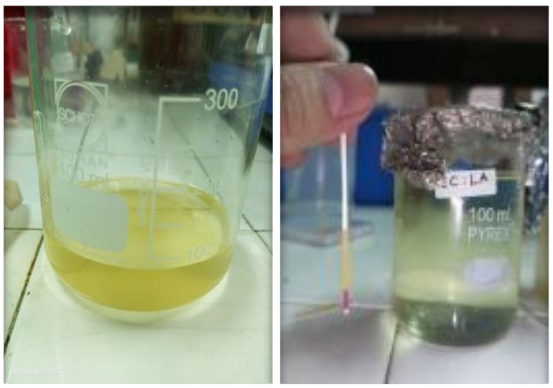

Figure 2. The NADESs A and NADESs B solutions

The literature states that the specific blend of NADES B materials used to create NADES B solution should have a pH of 1 and a molarity ratio of 1:2. Given that the solution's pH value was one and its physical form was colorless, the results were compatible with those of the reference literature. For molarity ratios of 1:12, 1:14, and 1:17, NADESs C should be clear in color and have pH values of 14.13 and 12. However, the 1:4 molarity ratio we used to create the solution had a pH of 11.5 instead. The 1:7 molarity ratio we used to create the solution resulted in a pH of 13. With a 1:12 molarity ratio, the solution we created had a pH of 12.5. The 1:4 solution had a brownish hue. The concentration ratios of 1:12 and 1:7, on the other hand, did not result in any color change. As a result of the Maillard reaction, which is brought on by the heat used during the manufacturing process, this 1:4 solution changes color and has a pleasant aroma.

Water Content Analysis

The extraction results are tested for water content by separating the pectin from the solution. The process of separating and washing pectin can be seen in Figure 3.

Figure 3. The process of separating and washing pectin

After obtaining the lumps, the solution and pectin were separated using a vacuum pump filter. The water and methoxyl contents of this pectin were then measured after it had been dried at 400C for 15 hours. The water concentration in pectin with a ratio of 1: 7 is significantly larger than the other ratios, according to the extraction data. The temperature that results in a higher water content at the extraction temperature utilized is 1000C. Data on pectin's water content are shown in Figure 4.

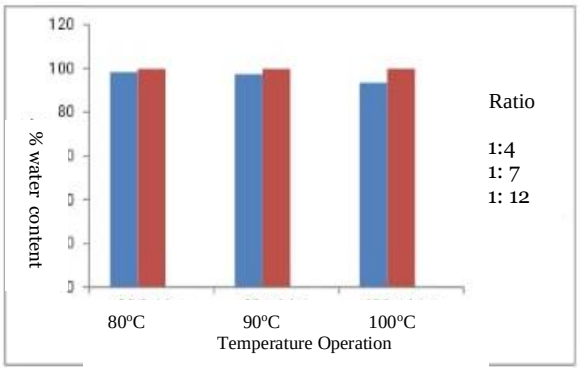

Figure 4. Pectin water content

Yield Pectin Analysis

In this investigation, the extraction method produced the maximum pectin output, following the discovery by a vacum pump that NADESS C, with a ratio of 1: 4 and a temperature of 90 oC, demonstrated a reasonably high pectin yield among all the ratios and temperatures provided. At 90°C and a K:G ratio of 1:1, 17.2 grams of pectin were produced from 1 gram of banana peel. Figure 5 shows the pectin yield that was attained during the extraction process.

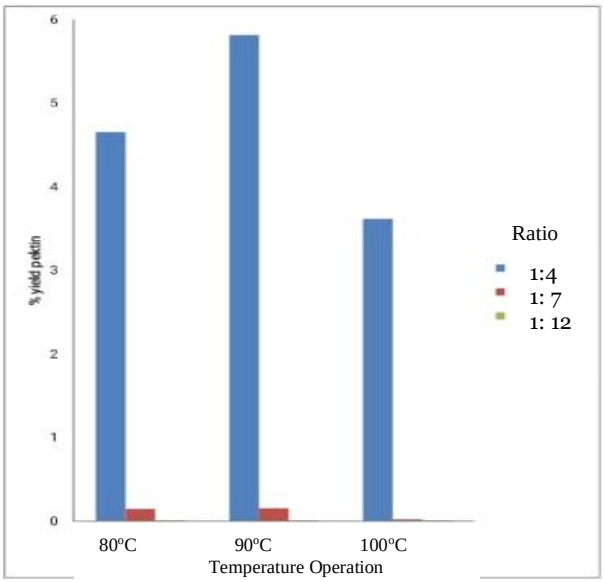

Figure 5. Yield pectin graph

According to the data, the greatest pectin yield rate in NADESS C, at a ratio of 1:4 and 90 °C, is 5.82%. With a ratio of 1:7 and a temperature of 90 oC, the pectin yield value is 0.15%. A 1:12 ratio does not result in pectin formation. Pectin degradation, which prevents pectin from forming completely, causes the yield of pectin to drop once again at 100 oC. The pectin obtained during the extraction method is shown in Figure 6.

Figure 6. Wet heavy pectin

Equivalent Weight Analysis

An equivalent weight was carried out to determine galacturonic acid from the sample. This test was carried out by titrating a sample that had been dropped with 2 mL of 96% ethanol and 1 gram of NaCl solution in 40 mL. The amount of NaOH titrated was recorded and then calculated to determine the equivalent weight in the extracted sample. In the sample results, the equivalent weight of pectin obtained was large, 5333.33 Gek.

This amount is greater than the standard maximum equivalent weight of pectin, which is 600 – 800[17]. The pectin sample used does not dissolve completely, causing the titration process to be disrupted. However, compared with other methods, the equivalent weight value obtained from this study is close to the extraction result using the HCl acid solvent method by Maulana (2015); namely, the equivalent weight is 5260 Gek[18].

Methoxyl Content Analysis

This methoxyl content determines the functional properties of pectin solutions and can affect the structure and texture of the pectin gel. In the methoxyl content test, the titrated solution of equivalent weight was added with 0.2 N NaOH and 0.2 N HCl until the colour of the solution changed back to clear. The methoxyl results obtained in the research sample showed that the sample methoxyl had a value of 2.79%. The methoxyl obtained belongs to the low methoxyl group because the methoxyl pectin content obtained is below 7.12%. It can be conclude the product is low gel pectin.

Galacturonic Acid Analysis

The galacturonic acid test was carried out to determine what percentage of the purity level of the extracted pectin. The higher purity of pectin make the better the quality of pectin. The galacturonic acid content was determined by calculating mEq NaOH in the equivalent weight test and mEq NaOH in the methoxyl content test. The galacturonic acid yield that we got was 76.56%. The value of galacturonic acid in the pectin sample is relatively high or quite pure. This is because the minimum limit value for galacturonic acid is 65%. Meanwhile, when compared to other methods, the yield of galacturonic acid from pectin extraction using NADES solvent this purity value is quite good. According to Maulana (2015), the galacturonic acid content obtained in the extraction process using HCl was obtained at 69.95% – 72.95%[18].

CONCLUSION (GEORGIA 12)

According to this study, the ratio of potassium carbonate to glycerol (1:4) produced the highest pectin yield of 5.81%,

while the ratio of 1:7 produced the highest pectin yield of 0.15%, and the ratio of 1:20 produced no pectin at all. The temperature variations used in the extraction process also had an impact on pectin yield, with the highest value being at 90°C and yields of 5.81% and 0.15%. The pectin yields were 4.65% and 0.14% with an ambient temperature of 80°C. In contrast, the pectin yield value at 100 oC, which is 3.6% and 0.078%, is the lowest. With a methoxyl level of 2.79% and a galacturonic acid concentration of 76.56%, the corresponding weight from the study was 5333.33, showing that this pectin is thought to be less pure.

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