Extraction and partial characterization of durian rind pectin

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Abstract. Durian which is famous for its plentiful nutrition, is a delicious fruit from Southeast Asia with rising popularity worldwide. Since durian rinds are often thrown away as waste, it would be beneficial to transform it into value-added product like pectin. In general, pectin is a complex carbohydrate molecule which broadly applied in food industries such as stabilizer, texturizer, emulsifier, thickeners, gelling agent and many others. The purpose of this research is to determine pectin content in durian rinds using conventional acid extraction and to characterize the properties of pectin in terms of yield, water activity, moisture content and ash content. Pectin was extracted using hydrochloric acid at pH 2.5, 85°C for 60 minutes. The statistical analyses were conducted by using Statistical Package for the Social Sciences (SPSS) and data obtained were reported in mean and standard deviation. The results indicated that durian rinds pectin yield is 73.67%, 11.53% moisture content, 4.67% ash content, and 0.452 water activity. The overall study highlighted that durian rinds are rich source of pectin and it is likely to become a significant raw material for food industries. The results of this research show successful pectin extraction, acquiring potential advantages for industrial pectin extraction economically and environmentally.

1. Introduction

Pectin is comprised of acidic polysaccharide and varieties of neutral sugars. The major chain of pectin comprises of α (1-4) associated with D-galacturonic acid which is partially esterified [1]. Pectin is categorized into two groups which are low and high methoxyl pectin. High methoxyl pectin (HM pectin) is pectin that has more than 50% content of methyl ester while pectin that has methyl ester content of below 50% is considered as low methoxyl pectin (LM pectin) [2]. Pectin extracted from several plant by-products are broadly used in the food industry for several reasons, for example stabilizers, thickeners, texture modifiers and gelling agents [3] as well as could be used in pharmaceutical and medical industries [4, 5].

Extraction is very important procedure in the pectin production. Pectic substances are commonly extracted by chemical or enzymatic methods, with physical and chemical multiple stages process, in which involves hydrolysis, extraction and solubilisation of macromolecules [6]. Extraction with hot water is the oldest and simplest procedure for recovery of pectic substances from plant tissues [7]. The
chemical methods to extract pectin are by chelating agents such as ammonium oxalate, EDTA (ethylenediaminetetraacetic acid), or sodium hexametaphosphate or by degradation by acid. Nevertheless, the most common method used to extract pectin is by acid extraction [8]. An appropriate method used to extract pectin is needed in obtaining the maximum pectin yield and their quality. In the meantime, durian rind was found to give a good source of pectin [9].

Durian is a fruit that is very well-known in the Southeast Asia mainly in Malaysia, Philippines, Thailand and Indonesia. The scientific name of durian is Durio zibethinus and this fruits are very popular with name of the "king of fruit". Durian has been grown smoothly and deeply in the industries of food processing for example durian ice-cream, candy, jam, and many others [10]. However, only one third of the entire portion of the durian fruit can be eaten while durian seeds and durian rinds are categorized as waste [11]. Nowadays, it has becoming a habit to the people to send the durian residues to the landfills or burn it without taking care of the surrounding environment. Thus, this can cause environmental pollution.

The accumulation of waste in the environment has raised the public awareness due to the problems on the quantity of durian wastes discarded into the environment. On the other hand, the huge volumes that are produced globally alongside with the diversity that these waste present makes them ideal candidates to be used for high value applications [12]. In previous phytochemical studies, bioactive components such as triterpenoids, coumarins, phenolics, lignans, flavonoids, sulfur-containing compounds, and some esters are found in the genus Durio [13, 14]. However, the knowledge on the durian rinds pectin is very limited. Thus, the objectives of this study were to determine the pectin content in durian rind using conventional acid extraction and to partially characterize properties of pectin extracted from durian rinds.

2. Materials and Methods

2.1. Sample collection
Durian fruits were collected from local durian fruit stall on the roadside located in Muar, Johor. In this study, Durio zibethinus fruit of cultivar D118 or very well-known with the name of “Durian Tembaga” were obtained in the mid-July of 2018. The selection of durian fruit is according to the size uniformity with average weight of 2.0kg ± 0.5 kg per fruit, colour and free from defects. Durians were cut open using a sharp knife. Durian arils were separated from the seeds and durian rinds manually. Subsequently, the rinds were cut into smaller pieces approximately 0.5 cm thick to facilitate the drying and grinding process of durian rind. Pieces of durian rinds were placed on the aluminium tray and were dried in a hot-air oven (AFOS, Hull, U.K.) at 60°C until a constant weight were achieved [15]. The dried durian rinds were ground into powder by using a grinder (Micro Universal Bench Top Grinder; Retsch ZM 100, Haan, Germany). After that, durian rind powders were packed into sealable plastic bags and stored in desiccator until the test was made [16].

2.2. Extraction of pectin
The dried durian rinds powder (100 g) were stirred into a 900 mL hydrochloric acid aqueous solution adjusted to the desired of pH 2.5. Then, the solutions were extracted at 85°C for 60 minutes. The slurries were filtered through cheesecloth and allowed to cool to room temperature at 25°C. Acidified ethanol in which 4% hydrochloric acid were added in 95% ethanol in the ratio of 1: 4 (v/v) and incubated for 60 minutes at 25°C. The mixture was then were centrifuged at medium speed for 15 minutes using benchtop centrifuge (Kubota 5100, Fujioka, Japan). After that, the solutions were rewashed twice with 95% ethanol (1: 2, v/v) and centrifuged for 15 minutes. The precipitate was collected and dried in a hot-air oven at 55°C for 24 hours or until constant weight was achieved [17, 18]. The dried pectin were ground for further experiments. Percentage of durian rind pectin yield collected was calculated as:

\[
Pectin\ yield, \ \% = \frac{weight\ of\ dry\ pectin\ obtained, \ g}{initial\ weight\ of\ durian\ rinds\ powder, \ g} \times 100
\]
2.3. Analysis and characterization of pectin

2.3.1. Moisture content Aluminiun dish was dried in an oven for 3 hours at 105°C, cooled in a desiccator and weighed. Pectin sample (5 g) was transferred to aluminium dish and placed in a hot air oven at 100°C for 5 hours. Then the petri dish was removed, cooled in a desiccator and weighed. Moisture content was done in triplicate. The heating procedure was repeated until a constant weight was achieved. The moisture content was calculated using equation below [19]:

\[
\text{Moisture, } \% = \left(\frac{w_2 - w_3}{w_2 - w_1}\right) \times 100
\]

(1)

\(w_1\) is weight of empty dish (g), \(w_2\) is weight of empty dish with sample before drying (g), and \(w_3\) is weight of container with sample after drying (g).

2.3.2. Ash content Total ash content of pectin was determined by using muffle furnace (Carbolite RHF 16-8, USA) [20]. Pectin sample (1 g) was inserted into crucible and ignited in muffle furnace at 600°C for 4 hours until greyish white residue were obtained. Ash content of durian rind pectin was done in triplicate. Finally, ash was calculated as below:

\[
\text{Ash, } \% = \left(\frac{\text{weight of ash, } g}{\text{weight of sample, } g}\right) \times 100
\]

(2)

2.3.3. Water activity, \(A_w\) The \(A_w\) content of durian rind pectin was measured using water activity meter (AquaLab Lite, USA) [21]. The sample was filled in the sample cups no more than half cup full and was put into \(A_w\) meter to test the water activity in the sample. The experiment was done in triplicate.

3. Results and Discussion

3.1 Pectin yield

The value of pectin content derived from durian rinds is shown in Table 1.

| Characterization of durian rinds pectin in terms of pectin yield, moisture content, ash content and water activity. | Results obtained |
|---|---|
| Pectin yield (%) | 73.67 ± 3.69 |
| Moisture content (%) | 11.53 ± 0.208 |
| Ash content (%) | 4.67 ± 0.577 |
| \(A_w\) | 0.452 ± 0.009 |

After the pectin as extracted at temperature of 85°C for 60 min and adjusted to pH 2.5 using hydrochloric acid, the amount of pectin obtained in this study was 73.67 % ± 3.69. In other studies, the yield of pectin from other fruit peels such as orange peel, sweet lime and papaya powder are ranging from 6.0% to 36.1%, 3.1% to 21%, and 4.0% to 19.1% respectively [22] while for jackfruit waste is about 38.42% [23]. This shows that pectin obtained from durian rinds give higher amount of pectin.
In this study, the use of hydrochloric acid to extract pectin would give higher pectin yield because hydrochloric acid is a strong acid and has higher ionic strength. The higher ionic strength of acid has greater capability to precipitate pectin because of their high affinity for cations, for example \( \text{Ca}^{2+} \) that stabilize pectin molecules. Therefore, with sufficient time, high amount of pectin could be precipitated out [24]. In addition, the structure of the durian rind is larger which consists of some proximate composition such as 85% total carbohydrate, 27.81% crude fiber and 73.45% of cellulose [25]. These residual rinds when extracted at high temperature could contribute to the yield of pectin due to the weakened of the rinds structure that increase the interaction between raw material and acidic solution and thus breakdown the pectin molecules leading to an effective high yield of pectin.

3.2 Moisture content
Moisture content is very crucial in determining the quality of food products and needs to be emphasized for preserving the materials when stored. This is to avoid enzymatic degradation and also prevent from the microbial growth [26]. From the results in Table 1, it exhibited that the moisture content of durian rind pectin was 11.53% ± 0.208. This means that the moisture content of durian rinds pectin was in the acceptable range which is lower than 12% [27]. Pectin is necessary to have lower moisture content to ensure that the material are safely stored as well as it could prevent or inhibit the microorganisms from growing that could affect the quality of pectin because of the pectinase enzymes production [28].

3.3 Ash content
Parameter of ash content revealed the inorganic impurities found in the pectin. Pectin may indicates as pure, good quality and have ability for better gel-forming when it contains low value of ash content [29]. The result obtained for ash content of durian rinds pectin as shown in Table 1 was found to be 4.67 % ± 0.577. It is observed that the value of ash content in durian rinds pectin is lower. The maximum limit of ash content in pectin must be 10% which indicates a good quality of gel criteria [30]. Thus, the lower ash content presents in this study shows the purity of pectin and also considered as a good pectin quality.

3.4 Water activity, \( A_w \)
Water activity is defined as the measurement on how efficient water is present in the molecules of food to participate in the chemical or physical reaction. It determines the lower limit of existing water for the growth of microorganisms. Based on Table 1, the \( A_w \) of durian rinds pectin obtained in this study was 0.452 ± 0.009. Durian rinds pectin displayed a low \( A_w \) since the \( A_w \) value of durian rinds pectin is below 0.6 [31].

A low \( A_w \) can prolonged the shelf life of materials while a foods with higher \( A_w \) which is more than 0.85 are tends to have short shelf life due to the exposure toward the spoilage of bacteria, molds, or yeast. Some research have found that freeze-dried jellies that have low \( A_w \) decreased the biochemical reactions rate in the products, therefore can increase product stability as well as prolonged the shelf-life of the product [32]. Thus, this study revealed low \( A_w \) could increase product quality and stability and also have longer shelf-life.

4. Conclusion
This research highlighted on the extraction and partial characterization of pectin from durian rinds. From the results, it showed that durian rinds pectin has a higher yield of pectin when compared with other fruit peels pectin. Interestingly, it was found that extracted durian rinds pectin contains low ash content, low moisture content and low \( A_w \). The lower ash content indicated high degree of purity for the industrial waste. Thus, this study revealed that durian rinds is a promising source of pectin with good quantitative characteristics. This could contributes for a more sustainable mass-production of various polysaccharides like pectin and its derivatives from agro-industrial waste.
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