Supply of avocado starch (Persea americana mill) as bioplastic material

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Supply of avocado starch (*Persea americana mill*) as bioplastic material

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Abstract. The purpose of this study was to determine the effect of time precipitation of avocado slurry seed to yield of starch. Starch analysis included starch content, moisture content, amylose content, amylopectin content, ash content, protein content, fat content, Fourier transform infra red analysis and rapid visco analyzer. Supply of starch from avocado seeds was used by extraction method. Every one hundred grams of avocado slurry was precipitated by gravity with variations for 4 hours, 8 hours, 12 hours, 16 hours, 20 hours and 24 hours. The Starch yield was washed, and dried using oven at 70°C for 30 minutes. Starch yield was the highest as 24.20 gram at 24 hours. The result of starch characterization was 73.62%, water content 16.04%, amylose 0.07%, amylopectin 73.55%, ash content 0.23%, protein content 2.16%, fat content 1.09%. Rapid visco analyzer obtained at 91.33°C of gelatinization temperature. Scanning electron microscopy analyzes obtained 20 μm oval-shaped starch granules. Fourier Transform Infra Red analysis of starch obtained the peak spectrum of O-H group of alcohols, C=H alkenes and C=O ether.

1. Introduction
The use of plastic packaging is increasing because it has advantages: lighter, not easily broken, and durable when compared to metal or glass materials [1]. Plastics have weakness: difficult to biodegradable, can not be renewed, so it need environmentally plastic materials (bioplastic) [2]. Bioplastics are made from renewable resources (starch) and biodegradable [3]. Starch is energy stored by green plants. Bioplastics material are made from potato starch, jackfruit seeds, sago, maize, avocado seeds and durian seeds [4-10]. Avocado seeds are easy to obtain (waste) and have a high starch content. Avocado seeds are extracted using water. The purpose of this research was to determine the effect of time precipitation of avocado slurry to yield of starch.

2. Material and Method
2.1 Material
Avocado seeds are obtained from the trader of juiceavocado in Binjai, Province Sumatera Utara, Glacial acetic acid, Chitosan, Ethylene glycol and Formic acid was obtained from UD. Rudang Jaya Sumatera Utara.

2.2 Extraction an avocado starch.
The an avocado seeds are cut thin [8, 11] with a thickness of ± 2 mm [12]. Repeatedly rinsed with water until clean and dried under the sun for 6 hours. The dried avocado seeds are blended by adding...
1:5 (w/v) water to form the slurry. The avocado seeds were taken the filtrate. Starch suspension was cooled and precipitated by time variation. Wet starch dried in an oven at a temperature of 50°C [9] for ± 24 hours to dry [13]. Starch dried ground and sieved to be a size of 100 mesh [10, 14].

2.3 Characterization of starch avocado seed
2.3.1 Starch, amyllose and amylpectin
Analyzing of starch, amyllose and amylpectin content was observed at Laboratorium Baristant Medan.

2.3.2 Ash content
Procedure of analyzing water content from avocado seed starch applied standard of AOAC. Sampel was scaled as much as 5 grams to be entered into porcelain dish. Dish filled with sample was fired on flame of bunsen burner until no haze appeared anymore. Then entered into furnace with temperature 550°C for ± 12 hours. Dish filled with sample was cooled in the dessicator then scaled until the weight was constant.

2.3.3 Protein and Fat content
Analyzing of protein and fat content was observed at Laboratorium Jasa Uji Ilmu Fakultas Teknologi Industri Pertanian Universitas Padjadjaran. Method used for this analyzing of protein content by method of Kjeldhal semimicro. Method used for this analyzing of fat content by direct extraction method utilizing soxhlet equipment.

2.3.4 Fourier Transform Infra Red Analysis (FTIR)
FTIR Analysis at Research Laboratory Faculty of Pharmacy University of Sumatera Utara, Medan.

2.3.5 Gelatinization profile analysis
Analysis of gelatinization profile in Laboratory of test service Faculty of Agricultural Industrial Technology Padjadjaran, Bandung.

2.3.6 Scanning Electron Microscopy (SEM)
Scanning Elecron Microscopy was conducted at Laboratory of Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan.

3. Result and Discussion
3.1 Rendement of avocado starch
The effect of variation precipitation time to avocado starch yield is presented by figure 1.

![Figure 1. Precipitation time of starch yield](image)

Figure 1 showed the longer precipitation time of starch slurry, the yield of starch is greater. Avocado slurry seed takes a long time to precipitat. The highest yield of avocado seed starch at 24 hours was 24.20%. One hundred grams of avocado seeds produce 24.20 grams of starch with precipitation time
of 24 hours. Cinelli, et al. [2006] reported time of starch precipitation for 24-48 hours until the starch precipitated perfectly.

### 3.2 Characteristics of avocado starch.
Characteristics of starch avocado seed aims to determine the percentage of components contained in starch produced. Characterization include starch content (amylose), water content, ash content, fat content, protein content, amyllose content and amyllopectin. Components of starch is presented by Table 1.

<table>
<thead>
<tr>
<th>Avocado starch component</th>
<th>Level (%)</th>
<th>Indonesia Standard (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch (amylose)</td>
<td>73.62</td>
<td>min 75</td>
</tr>
<tr>
<td>Amylose</td>
<td>0.07</td>
<td>-</td>
</tr>
<tr>
<td>Amylopectin</td>
<td>73.55</td>
<td>-</td>
</tr>
<tr>
<td>Water</td>
<td>16.6</td>
<td>max 14</td>
</tr>
<tr>
<td>Ash</td>
<td>0.23</td>
<td>max 1.5</td>
</tr>
<tr>
<td>Fat</td>
<td>1.09</td>
<td>-</td>
</tr>
<tr>
<td>Protein</td>
<td>2.16</td>
<td>-</td>
</tr>
</tbody>
</table>

#### 3.2.1 Starch content
The starch content is the quantity of starch contained in the dry matter expressed in percent. The purpose analysis of starch content to determine the percentage of starch/amylose (per unit of starch powder mass). The result of avocado starch content was 73.62%. Based on Indonesian Industry Standard (SII), the starch content was at least 75%, the starch content has approach SII. Difference of starch content is effected by the level of purity during the starch extraction process, in which the more the mixture in the starch powder obtained, such as the fibers, the sand/impurities then lower of starch content per mass unit [7].

#### 3.2.2 Amylose and Amylopectin content
The purpose of this analysis to determine amylose and amyllopectin content at avocado seeds. Starch consists of two types of polysaccharides: amylose and amyllopectin. Amylose has several branch linear molecule chain, amyllopectin is branch molecule chain. One hundred milligrams avocado starch was obtained amyllose 0.07% and 73.55% amyllopectin content. The ratio between amylose and amyllopectin determines the physico-chemical properties of starch, such as gelatinization and retrogradation [14]. Low amylose levels cause high viscosity and low pasting temperature, while high amylose levels cause low viscosity and high pasting temperatures [15].

#### 3.2.3 Water content
The water content shows the quantity of water in a material, water bound or free water, compared to the mass of the material [16]. The purpose of this analysis known the water content in starch that affects the bioplastic characteristics. The moisture content of a material will determine the acceptability, freshness and durability of the material. The result of the water content is 16.6%. Based on Indonesian Industry Standard (SII), water content is at least 14%. Water content not yet approaching SII.

#### 3.2.4 Ash content
Ash content is the content in the form of chemical compounds and has an important role in determining the quality and resistance of a material [17]. Ash is an inorganic residue of burning organic matter. Ash content can be calculated based on the reduction of sample weight during the combustion process at high temperature (500-600°C) through the vaporization process of organic material. The higher ash content then the higher the mineral content of the food [15]. Ash content was 0.23%. Based on Indonesian Industry Standard (SII), ash content was at least 1.5%. Ash content was already meets SII.
3.2.5 Fat content
The purpose of this analysis is to know the fat content of starches. Fat content obtained 1.09%. The desired fat content is as small as possible because it interferes with the gelatinization process, inhibiting the release of amylose from starch [18]. Increased fat content will significantly decrease the degree of starch gelatinization. The effect of oil/lubricant from fat, which resulted in decreasing product temperature and decreasing the degree of gelatinization.

3.2.6 Fourier Transform Infrared (FTIR)
Characteristics Fourier Transform Infrared of avocado starch is presented by figure 2.

![FTIR Spectrum](image)

**Figure 2.** Fourier Transform Infra Red (FTIR)

The FTIR of avocado starch seed obtained by C-O ether, O-H, C-H alkane groups. The resulting functional groups have represented starches such as amylose and amylopectin [19,20]. FTIR analysis wave number 1246.02 cm⁻¹, 3394.72 cm⁻¹ and 2927.94 cm⁻¹ showing C-O ether, O-H, C-H alkane groups.

3.2.7 Rapid Visco Analyzer (RVA)
Rapid Visco Analyzer (RVA) to determine the starch gelatinization profile avocado seed. Characterization related to the measurement of starch viscosity with a certain concentration during heating and stirring. The results of Rapid Visco Analyzer and measurement parameters are presented by figure 3 and table 2.

![RVA Graph](image)

**Figure 3.** Rapid visco analyzer starch avocado seed
Table 2. Parameters measured RVA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Avocado starch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Viscosity</td>
<td>674 cP</td>
</tr>
<tr>
<td>Hold Viscosity</td>
<td>669 cP</td>
</tr>
<tr>
<td>Final Viscosity</td>
<td>1273 cP</td>
</tr>
<tr>
<td>Breakdown</td>
<td>5 cP</td>
</tr>
<tr>
<td>Setback 1</td>
<td>604 cP</td>
</tr>
</tbody>
</table>

Table 2 showed parameters measured pasting temperature, peak viscosity, hold viscosity, final viscosity, breakdown and setback viscosity. Gelatinization process heat the starch with excess water at a certain temperature so that there is an increase in swelling power and viscosity starch. Temperatures at viscosity increase and at start gelatinization is called pasting temperature. The optimum viscosity or Peak Viscosity (PV) is a parameter of the starch granule's ability to bind water and retain swelling during heating [21]. During the holding period, the sample is affected by the mechanical stress-strain properties that cause starch granules and the amylose leaching process. Viscosity during the holding period is called Hold Viscosity (HV). When samples are periodically cooled and increased viscosity is called Final Viscosity (FV) which is related to the process of retrogradation of amylose molecules [22]. Breakdown viscosity is the difference between PV and HV, stating the paste stability against heating. Breakdown causes to differences in viscosity when swollen, starch granules have been gelatinized and viscosity when the starch-grained granules are partially or partially disrupted [23]. Setback 1 is the difference between HV and FV, indicating the ability of the starch paste to be retrograde, the process of reforming the gelatinized starch matrix. The Setback viscosity implies degrees of retrogradation [24]. The gelatinization temperature profile comprises several phases. The first phase begins at a temperature below the starch gelatinization temperature, low viscosity and starch measurable starts accruing thermal treatment at a temperature of 48°C. The second phase, the temperature is gradually increased until it reaches a temperature of gelatinization, which is the temperature at which the starch granules begin to swell and the viscosity increases. Table 2 shows the temperature of avocado starch gelatinization of 91.33°C.

3.2.8 Scanning Electron Microscope (SEM)
Characteristics of Scanning Electron Microscope (SEM) avocado starch is presented by figure 4.

![Figure 4 Scanning Electron Microscope of Starch Avocado Seeds](image)

Scanning Electron Microscope 1500x enlargement with starch size of 100 mesh. The analysis is showed the shape of rounded or elliptical starch granules and has a granule size of 20 μm. Form of
oval starch granules, average granular size of 5-35 µm. Starch has a gap and is free of pores Starch granules not yet modified process have a smooth and intact surface[24].

4. Conclusion
The best yield of avocado seed starch is 24.20 gram at 24 hours deposition. Characterization of starch obtained 16.6% moisture content, ash content 0.23%, 73.62% starch content, Kadar 0.07% amyllose, amylopectin content of 73.55%, 2.16% protein content, fat content of 1.09%, gelatinization temperature of 91.33°C peak viscosity of 674.5 cP.

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