Characterization of chemical properties and color of starch from *Talas Beneng (Xanthosoma undipesh K. Koch)* extraction as a source of indigenous carbohydrate from Pandeglang regency, Banten province

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Abstract. Indonesian are very dependent on wheat flour, even though wheat are subtropical plant. Therefore, the Indonesian government must import wheat continuously to supply the demand. While there are many potential local carbohydrates sources that have not been utilized such as tubers. One of local carbohydrates source is *Talas beneng* which only grows in Pandeglang Regency, Banten. This tuber grows wildly and is underutilized because it contains oxalate which causes itching when consumed. Oxalate reducing is done by soaking the taro in 1% NaCl for 60 minutes. To easier application on food products, this tuber can be made as starch. The aim of this study were to choose the best extraction method in producing starch and determine the color and chemical characteristics. The extraction method used was carried out with five attempts and two repetitions, with a ratio of taro and water 1:1, 1:2, 1:3, 1:4, and 1:5. The results showed that the ratio that produces the biggest yield is 1:3 with the result 12.67%. Chemical characteristics of *talas beneng* starch are produce an L value 100,00, a* 10.92, b* -15.54, and contains moisture 6.21%, ash 0.25%, fat 10.56%, protein 0.66%, starch 82.32%, amylose 28.91%, amylopectin 53.41%, and oxalate reduction 97.4%.

1. Introduction
Food is an important basic human needs besides clothing, education, and health. Without food, humans cannot live. Almost all snacks, traditional foods, and staple foods in Indonesia are made from wheat flour. Therefore, Indonesian people are very dependent on wheat flour. The Indonesian Flour Producers Association (Aptindo) revealed wheat imports in 2017 rose by around 9% to 11.48 million tons from the previous year. Dependence on certain foods can cause national food security to become fragile. Meanwhile there are still many potential food sources that have not been utilized optimally such as local food likes tubers. If Indonesian people can take advantage of local food this will undoubtedly be able to create resilient food security [1].

One method that can be used to reduce the use of wheat flour in food products is to substitute it with *talas beneng* flour or starch. *Talas beneng (Xanthosoma undipesh K. Koch.)* is a local tuber that only grows in Pandeglang Regency, Banten Province. The size of this *talas beneng* is very large, grows wildly, and the color of tubers are yellowish [2]. *Talas beneng* has protein content of 6.29%, carbohydrates 84.88%, fat 1.12%, starch 75.62%, and calories 374.69 kcal [3]. With its large size and rich of nutrients, *talas beneng* is very potential to be applied in food products.

*Talas beneng* contains oxalate which can cause itching when consumed. Oxalate content in *talas beneng* are the highest compared to Bogor, Malang, and West Kalimantan taro [4]. The method used to reduce the oxalate content that is often used by the Pandeglang community is to soak it in a solution of...
1% NaCl for 1 hour. For easier application of talas beneng in food products, it can be made as starch. Starch is homopolymer of glucose with α-glycosidic bonds. The characteristic of starch depends on the length of the carbon chain and the content of amylose and amyllopectin. Each plant has a distinctive and different shape and size of the starch granules. Starch is composed of at least three main components, amylose, amyllopectin and intermediate materials such as protein and fat. In general, starch contains 15-30% amylose, 70-85% amyllopectin, and 5-10% intermediate material [5].

The aim of this research were to see the best extraction method to produce the largest yield of talas beneng starch and then determine of proximate, amylose, amyllopectin, color, and oxalate contents in talas beneng starch.

2. Research methodology

2.1. Time and place of research
This research was conducted at the Laboratory of Food Technology and Agroecotechnology, Faculty of Agriculture, University of Sultan Ageng Tirtayasa in June-August 2019.

2.2. Tools and materials
The tools that used are set of kitchen tools (knives, cutting boards, basins, buckets), analytical balance, strainer, blender, baking pan, and oven for extracting and drying starch. Oven, furnace, cup, desiccator, soxhlet, kjeldahl apparatus, UV-Vis spectrophotometer (Perkin Elmer), HPLC UV-Vis (Agilent), chromameter (Minolta CR-300), and a set of glassware (Pyrex).

The materials that used were a talas beneng obtained from Juhut Village, Karang Tanjung District, Banten Province, NaCl salt, aquades, hexane, H2SO4 (merck), HgO (merck), NaOH (merck), H3BO3 (Sigma Aldrich), HCl (merck), aquabidest, phenolphtalein (Sigma Aldrich), ethanol 95%, amylose standard (Sigma Aldrich), acetic acid (merck), iodine (merck), and oxalate standard (sigma Aldrich).

2.3. Characterization of diameter, length, weight, color of talas beneng and extraction of starch
The process carried out is to observe the diameter, length, weight, skin color, and tuber color of talas beneng. The next step is extraction of talas beneng starch begins with washing, sorting, stripping, slicing, soaking in 1% NaCl salt solution, crushing with water for 5 minutes, filtering, settling for 24 hours, starch, and water separation, drying at 50°C for 24 hours, and size reduction. This extraction process was carried out in five attempts and two repetitions. The ratio of taro and water used for extraction is 1:1, 1:2, 1:3, 1:4, 1:5.

2.4. Determination of yield and proximate content
This extraction process will be chosen of the highest yield of starch. The yield is calculated using the formula:

\[
\text{Yield} = \frac{\text{Weight of Talas beneng}}{\text{Weight of Dry Starch}} \times 100\% \quad (1)
\]

Starch with the highest yield was analyse of proximate, amylose, amyllopectin, degree of color, and oxalate contents. Proximate analysis was carried out of moisture content by gravimetric method (AOAC 2006), ash content by gravimetric method (AOAC 2006), protein content by Kjeldahl method (AOAC 2006), fat content by Soxhlet method (AOAC 2006) and carbohydrates (by difference).

2.5. Amylose and amylopectin content [7]
Analysis of amylose content using the spectrophotometric method with the principle of staining using iodine and calculated with blue value. 100 mg sample was placed in a test tube, then added with 1 mL of 95% ethanol and 9 mL of 1N NaOH. The mixture is heated in boiling water to form a gel and then the whole gel is transferred to a 100 mL measuring flask. The gel is added to distilled water and shaken, then adjusted to 100 mL with distilled water. A total of 5 mL of solution was put into a 100 mL measuring flask and added with 1 mL of 1 N acetic acid and 2 mL of iodine solution. The solution is
fixed to 100 mL, then shaken and left for 20 minutes. The intensity of the blue color was measured by a spectrophotometer at a wavelength of 625 nm. Amylose content is calculated based on the standard amylose curve equation. The absorbance value obtained is entered into the standard amylose curve so the amylose % value will be obtained.

Carbohydrate content is considered as starch content, because the non-starch component of talas beneng has been removed during the extraction process. Starch is a combination of amylose and amylopectin. Amylopectin contents are calculated based on the starch content reduced by amylose content.

2.6. Degree of color
The degree of color is measured by chromameter. The color notation system used is a hunter system namely L* (brightness), a* (+ red, - green), b* (+ yellow, - blue). For calibration, chromameter is placed on white paper first. Chromameter is placed on the starch precisely without any gaps then the measurement button is pressed. The light source is on and the reflectance is measurable.

2.7 Oxalate content [8]
5 grams of talas beneng are crushed and placed in 100 mL Erlenmeyer flasks. To this, 50 mL of HCl 2M (pH 0.08) was added for total oxalate analysis or 50 mL of distilled water (pH 7) for analysis of water-soluble oxalate. The mixture is homogenized and then covered with parafilm and placed in a waterbath (80 °C) for 20 minutes with periodic shaking. The sample is transferred to a 100 mL volumetric flask and water or acid is added to the pitch mark, then centrifuged at 1400 x g for 15 minutes. The supernatant was obtained and filtered with 0.45 μm cellulose acetate milipore and then analysed by HPLC. The column conditions that used were Aminex HPX-87H 300 mm x 7.8 mm, mobile phase 4 mM sulfuric acid, elution time 20 minutes, flow rate 0.6 ml/minute, column temperature 25°C, injection volume 20 μL, using multiwavelength detector and UV detection at 215 nm. The results obtained are compared to the oxalate standard.

3. Results and discussion
3.1. Physical appearance of talas beneng
Talas beneng is a unique taro because it has a large size compared to other taro. Table 1 shows that the weight of taro reached 832.23 grams, 5.64 grams in diameter, and 20.93 grams in length.

| Physical Appearance | Characteristic     |
|---------------------|--------------------|
| Length              | 20.93 cm           |
| Diameter            | 5.64 cm            |
| Weight              | 832.23 grams       |
| Color of Skin       | Reddish Brown      |
| Color of Tuber      | Yellowish white    |

The average weight of taro is 100 grams, so the table above shows that talas beneng has a very large size compared to other taro. The length and diameter of the large taro will affect the weight produced [9]. Talas beneng color is yellowish white, this is caused by the presence of β-carotene pigments. The level of β-carotene found in the yellowish taro tubers is around 0.0213 mg/100 g [10]. Talas beneng skin color is reddish brown caused by plant varieties, growing sites, nutrients obtained, and weather factors [3].
3.2. *Talas beneng* starch extraction
The extraction method used was wet extraction using water. The ratio of taro and water used was 1:1, 1:2, 1:3, 1:4, and 1:5.

| Taro: Water | Yield   |
|-------------|---------|
| 1:1         | 3.51%   |
| 1:2         | 9.16%   |
| 1:3         | 12.67%  |
| 1:4         | 10.02%  |
| 1:5         | 12.10%  |

The extraction process is the most important thing in getting starch. On the table above, it can be seen that the ratio of 1:3 between taro and water produces the most yield. Yield starch resulting from the ratio of taro: 1:1 water extraction is the least, this is because the characteristics of *talas beneng* are hard and more difficult to crush, so the less water the more difficult to extract starch [2]. Ratio of 1:4 and 1:5 give smaller yield than 1:3 because some of the starch is dissolved and wasted in large amounts of water.

3.3. Color
Color is one of the important attributes that used to determine the quality of a food ingredient. Taro starch from 1:3 extracted was analysed for color attributes including L* value, indicating dark-light level with a range of 0-100, a value of 0 indicates black or very dark and value of 100 indicates a white or bright color tendency. a* value indicate the intensity of red (+) or green (-). b* value represents the intensity of the color yellow (+) or blue (-).

*Talas beneng* starch and tapioca starch are derived from the extraction of tubers. According to SNI 3451: 2011 about tapioca, the color quality requirements of starch are white with a minimum degree of white is 91. The color attributes of *talas beneng* starch are L* 100.00, a* 10.92, and b* -15.54. The L * value indicates that the white degree of *talas beneng* starch is perfect and exceeds the tapioca color standard. This perfect white color is obtained because there are no other components such as pigments that have been separated when the starch extraction process.

3.4. Chemical Characteristics
Chemical characteristics are a very important attribute in determining starch quality and its application in food products. *Talas beneng* starch with extraction ratio 1:3 contains 6.21% moisture content (Table 3), the moisture content requirements in tapioca according to SNI 3451: 2011 is maximum of 14%. This showed that the moisture content of *talas beneng* starch is better than tapioca standard. Therefore, the shelf life of *talas beneng* starch will be long because of moisture content less than 14%, the growth of microorganisms, especially mold will be inhibited [5].

The levels of ash in *talas beneng* starch reached 0.35% (Table 3), the quality requirements for tapioca ash according to SNI 3451: 2011 is maximum of 0.5%. This showed that the ash content of *talas beneng* starch is better than tapioca. The greater the ash content in flour, the worse the quality will be. In addition, if the flour or starch to be applied to food has high ash content, it can affect the fermentation activity, the strength of the dough, the color, and the final product, especially bread products [12].
Table 3. Chemical Characteristics of *Talas beneng* Starch

| Characteristics    | Content (%) |
|--------------------|-------------|
| Moisture (%)       | 6.21        |
| Ash (%)            | 0.25        |
| Fat (%)            | 10.56       |
| Protein (%)        | 0.66        |
| Carbohydrate (%)   | 82.32       |
| Amylose (%)        | 28.91       |
| Amylopectin (%)    | 53.41       |

The fat content of *talas beneng* starch is 10.56% (Table 3). High fat content in food will accelerate rancidity so that it will reduce its quality [5]. Beside that, high fat in flour or starch will inhibit starch gelatinization due to the fat forming complex with amylose. The gelatinization process is inhibited because the fat is absorbed by the surface of the starch granules and forms a hydrophobic layer [2].

The protein content of *talas beneng* starch is 0.66% (Table 3). The quality standard of protein content in wheat flour according to SNI 3751: 2009 of wheat flour is a minimum of 7%. This low protein level results in *talas beneng* starch can be used for food ingredients in products that do not need development such as cookies, vermicelli, and glass noodles.

Carbohydrate content in *talas beneng* starch is considered as starch, which is 82.32%. These results are better than the standard tapioca according to SNI 3451: 2011 is 75%. The more starch content, the *talas beneng* starch can be used as a source of carbohydrates and substitute ingredients for wheat flour in various food products.

Amylose is part of the polymer with α- (1,4) bonds from 500-2000 D-glucose units and form a straight chain. Amylose content of *talas beneng* starch reached 28.91%, while amylose content in potatoes as much as 10%, wheat 25%, tapioca 15-18%, and rice 20%. Amylose content of 25-30% can provide character and texture strength of a compact gel [5].

Amylopectin is a branch chain polymer with α- (1,4)-glycosidic bonds and α- (1,6)-glycosidic bonds at its branching site. Each branch consists of 25-30 units of D-glucose. Amylopectin chain structure tends to form branches that make up 4-5% of all amylopectin structure [5]. Amylopectin content in *talas beneng* starch is 53.41%. In food products, amylopectin is stimulating the process of puffing, in which food products derived from starch with high amylopectin content will be mild, porous, and crisp [5].

Based on the composition of amylose and amylopectin, *talas beneng* starch contains higher amylose content than other ingredients. Because of its higher amylose content, *talas beneng* starch is suitable for use as an ingredient in food that does not need crisp, development, porous, and requires character and strength of gels such as vermicelli, glass noodles, noodles, and other traditional cakes.

### 3.5. Oxalate contents

Consumption of *talas beneng* can cause itching and irritation to the lips, mouth and throat. Itching that stimulates the oral cavity and skin is caused by the presence of small crystals in the form of fine needles composed of calcium oxalate called raphide. Oxalate (C₂O₄²⁻) in taro is in the form of water-soluble (oxalate acid) and water-insoluble (calcium oxalate or oxalate salt) [4].
Talas beneng has the highest contents of oxalate compared to other taro. The oxalate content in Bogor, talas beneng, West Kalimantan, and Malang taro is 8.58 mg/g, 61.78 mg/g, 7.33 mg/g, and 10.887 mg/g [4]. The Pandeglang community used to soak the taro in 1% salt solution for 1 hour to reduce their oxalate content, so the itching will disappear when consuming talas beneng or its processed products.

In this study, talas beneng was soaked in a solution of 1% NaCl salt for 1 hour, the results showed that the oxalate content of talas beneng starch are 1.61 mg/g or oxalate reduction is 97.4%. This result is in accordance with Mayasari’s study that soaked taro in a 10% NaCl solution for 1 hour showed an oxalate reduction of 96.83% [4]. Decreased contents of oxalate occur because of the reaction between sodium chloride (NaCl) and calcium oxalate (CaC$_2$O$_4$). Salt (NaCl) dissolved in water breaks down into Na$^+$ and Cl$^-$ ions. The Na$^+$ ion attracts negatively charged ions and Cl$^-$ ion attracts positively charged ions. In this reaction Na$^+$ ion bind C$_2$O$_4^{2-}$ ion to form sodium oxalate (Na$_2$C$_2$O$_4$) which can dissolve in water with a solubility of 3.7 g/100 ml at 20ºC and 6.25 g/100 ml at 100ºC, and Cl ion will bind ion Ca$^{2+}$ forms a white precipitate of calcium dichloride (CaCl$_2$) which is easily soluble in water [4].

4. Conclusion
The best extraction method to get the highest yield of talas beneng starch is using a ratio of taro: water 1:3. Oxalate reduction on talas beneng by soaking taro in 1% NaCl salt solution for 1 hour and succeeded in reducing oxalate in taro starch by 97.4%. The water content, ash content, and starch content in talas beneng starch do not exceed the standards of SNI 3451: 2011 of tapioca. Amylose and amylopectin content of talas beneng starch are 28.91% and 53.41%, so that this starch is suitable for application in food products that require compact gel strength such as vermicelli, glass noodles, or noodles.

5. References
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