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EFFECT OF BLANCHING ON THE PHYSICOCHEMICAL CHARACTERISTICS AND MICROSTRUCTURE OF CANISTEL SEED FLOUR (*Pouteria Campechiana (Kunth) Baehni*)

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ABSTRACT

Canistel seeds are part of the residues of Canistel fruit which can be used as functional foods, such as flour to be processed into various foods. This research was aimed at determining the physicochemical properties of canistel seed flour. Canistel seed was made into flour with two treatments; they were Blanched Canistel Seed Flour (BCSF) (at 80ºC for 10 minutes) and Unblanched Canistel Seed Flour (UCSF). The flour process involves sorting, washing, treatment, stripping the shell and epidermis, washing again, drying, flaking and sieving. Physical analysis carried out included yield (by difference method), white degree of spectrophotometric reflectance method (Chromatometer), starch gelatinization profile using Rapid Visco Analyzer (RVA), the morphology of starch granules using polarization microscopy and Scanning Electron Microscope (SEM). Chemical analysis conducted on the BCSF and UCSF samples included proximate, amylose, amylopectin and starch content. Blanching at 80°C for 10 minutes had a significant effect on the physical properties of Canistel seed flour; yields were higher (41.6%) and chromatometric (colour) levels were lower (80.61). Pasting properties profile showed that UCSF had higher peak viscosity, breakdown viscosity but lower setback viscosity compared with the BCSF. Scanning Electron Microscope (SEM) and polarized light microscope showed starch granule structure changed due to the blanching. The appearance of starch granules on UCSF shows a tight starch granule. The appearance of starch granules on BCSF shows blanching treatment has changed the shape of the starch granules to be broken or damaged. The unblanched canistel seed flour (UCSF) showed that the starch granule still had birefringence appearance. This shows that the granule structures of the UCSF remained undamaged. Observation of the morphology of starch granules using polarization microscopy on BCSF showed the starch granule was not visible and there was no appearance of birefringence. The loss of birefringence indicates that the starch granules had been damaged due to heating or hydrolysis. Chemical analyses on the samples showed significantly higher amylose content (24.79) but lower amylopectin content (31.39) in BCSF than UCSF. Starch, fat and carbohydrates contents were not significantly different ($p>0.05$) between BCSF and UCSF. Ash and protein content were significantly higher ($p>0.05$) in UCSF compared to the BCSF. Blanching of canistel seed flour reduces the swelling power of starch granules, increases retrogradation, accelerates thickening, decreases nutrition content, and changes microstructure of Canistel seed flour.

Key words: Blanching, canistel seed flour, physicochemical characteristics, starch granule morphology, proximate

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INTRODUCTION

Canistel fruit contains nutrients such as fiber, starch, calcium, phosphorus, carotene, thiamine, riboflavin, niacin and vitamin C. The flesh can be frozen or dried and made into flour [1]. Canistel seed coat has a hard-colored brown shell and white epidermis, with a yellowish-white canistel seed content. In one Canistel there are 1-5 seeds; however, they have not been used optimally. In several studies that have been done, Canistel seeds can be used in the pharmaceuticals and food industries [1]. Costa *et al.* [2] reported that Canistel seeds had higher total lipid content than fruit flesh. Elsayed *et al.* [3] investigated that the phytochemical content and biological activity in ethanol extracts of leaves and Canistel seeds can be used for traditional medicine for inflammation and pain. Sunila and Murugan [4] reported that the content of unsaturated fatty acids is relatively high, so Canistel seed oil has the potential to be developed in the fields of food, cosmetics, and energy. Flour is a form of processing material by removing the water content and grinding so that it affects the increase in shelf life and facilitates storage [5]. Flour is an alternative form of semi-finished product because it will be more resistant to storage, easy to mix, mold and cook faster [5]. Differences in physical and chemical properties affect the functional properties of flour when it is processed into food. The characteristics of the flour are determined by the physical and chemical properties contained in the origin of the flour and the manufacturing process carried out when making flour [6].

Canistel seed flour has a high starch content in the form of amylose and amylopectin so that it can be used as an alternative to wheat flour substitution [6]. Blanching can cause physical and chemical changes that result in changes in the texture and structure of the food [7]. These changes depend on the temperature and the duration of blanching, as well as the type and condition of the material being blanched [8]. After blanching, the campolay seed coat is soft and easier to peel. Blanching affects reducing sugar levels and starch levels in flour; with a higher temperature it will change the shape of starch into degraded starch, hence more damaged starch granules [7,8].

Blanching is a food heating technique that aims to inactivate browning enzymes (polyphenol oxidase, peroxidase and catalase), remove unwanted odors and flavors, preventing the oxidizing activity of ascorbic acid, soften the texture and reduce contamination of spoilage and pathogenic microorganisms in canistel seeds flour [7,8]. Blanching temperature used ranges from 55-80 °C for 10-15 minutes [7,8]. During the blanching process, changes in the color of the material due to heat causes the change in chlorophyll to pheophytin which is yellow green [9,10]. In carotene-containing materials, the carotene color changes due to heat which induces changes in the conjugation structure of the carotene, the proportion of red increases, while the proportion of yellow decreases [9,10].

Some of the effects of the blanching process on food are that there is a large shrinkage causing a high enough weight loss [7]. This weight loss can reach 19% due to temperature conditions of 50-55 °C so that the cytoplasmic membrane that protects the inside of the cell becomes damaged and causes loss of turgor pressure [8]. This situation causes loss of fluid from the inside of the cell. Simultaneously, damage to the membrane causes

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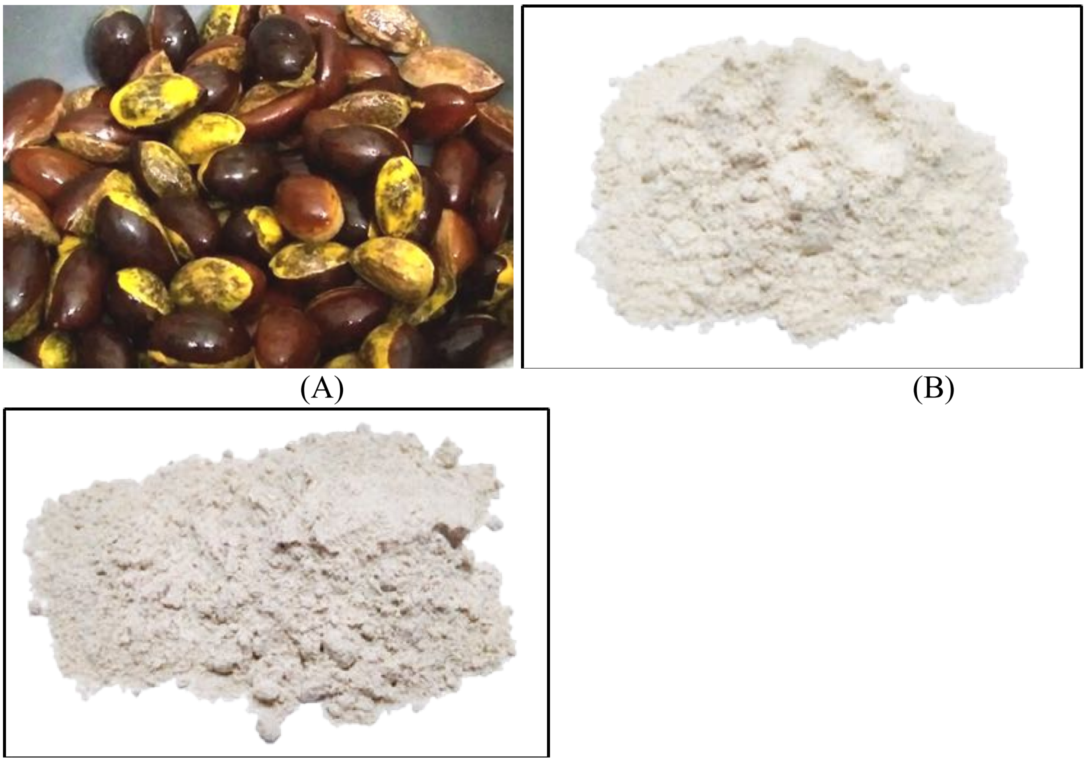
diffusion of solutes from the inside of the cell. Diffusion that occurs continuously during the blanching process causes severe shrinkage [7,8]. In addition, blanching also affects the nutritional component. The cooking process, however, could damage nutrients which are highly sensitive to heat, light and oxygen [8]. Damage to some nutrients occurs during the blanching process, but among various methods, the boiling method causes the greatest nutrient loss. As much as 40% of minerals and vitamins, 35% sugar, and 20% of protein are damaged in the boiling process [7,8]. This study aimed to analyze the effect of blanching on the physicochemical characteristics and microstructure of Canistel seed flour.

MATERIALS AND METHODS

Canistel seed collection

Canistel seeds (100 pieces) were obtained from Canistel fruits from farmer Cipatat, Bandung, West Java, Indonesia (Figure 1). It was transported for 5 hours to Ciawi, Bogor, West Java, Indonesia and stored at 4^{o}C refrigerator (Samsung, Korea) before blanching treatment.



(A) (B)

(C)

Figure 1: (A) Canistel seeds, (B) Unblanched Canistel Seed Flour (UCSF), and (C) Blanched Canistel Seed Flour (BCSF)

Canistel seed blanching

Canistel seeds are derived from the separation between fruit flesh and seeds. The stages of production for Canistel seed flour include sorting, first washing, without blanching

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(UCSF) and with blanching (BCSF) at a temperature of 80 ℃ for 10 minutes. Sorting aims to separate bad canistel seeds (rotten, moldy, foreign matter) from good canistel seeds. Good quality canistel seeds are used for the next process. The first washing uses water to clean the dirt that is attached to the canistel seeds. Blanching aims to help smooth the texture of the shell skin of canistel seed. The heating is carried out using an autoclave (Hirayama, Japan) at 80℃ for 10 minutes.

Canistel seed flour preparation

Both blanched and unblanched canister seeds were made into flour by stripping the shell and epidermis, second washing, washing downsize, drying using a cabinet dryer, flaking, mashing and sieving with a mesh size of 60. Both blanched and unblanched canister seeds were prepared. The skin stripping aims to separate the contents of the canistel seeds with shell and epidermis. Next, the second washing uses water to ensure that the canistel seeds are completely clean from the shell and epidermis. The next stage is draining using a perforated stainless container aimed at reducing washing dirty water. Then reduce the size by thinner cutting using a slicer machine, aiming to speed up the drying process. Canistel seeds that have been thinly cut are then dried in oven (Shimidzu, Japan) at 60°C for 4 hours. After drying, the process of mashing using a dry blender (Phillips, Netherlands) until smooth and then sieved with 60 mesh sieves. The canistel seed flours from the two were designated as BCSF and UCSF (Figure 1).

Determination of physical properties

Colour properties

Measuring the colour properties was done by using Chromameter CR-400 Konica Minolta (Tokyo, Japan) (Figure 2) with placing the BCSF and UCSF sample in the hole through which the light passes, so that no light escapes, then recording the values of L*, a*, and b*. The CR-400 Series features a User index function to configure the evaluation formula and color calculation formula as desired. L* (brightness), a* (reddish/greenish), and b* (yellowish/bluish). White degrees are calculated using the following equation: Whiteness = $[(\Delta L^*)2 + (\Delta a^*)2 + (\Delta b^*)2]^{½}$

Figure 2: Chromameter CR-400 Konica Minolta to analyze degree of whiteness

Gelatinization Profile

Gelatinization profile of the BCSF and UCSF were measured following Sharlina *et al.* [11]. Three grams of the canistel flour was weighed in Rapid Visco Analyzer (RVA) 4800 (Perkin Elmer, USA), and then 25 ml of distilled water added. Measurements with RVA 4800 (Perkin Elmer, USA) include the heating and cooling process phases at

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constant stirring (160 rpm). In the heating phase, the starch suspension is heated from 50ºC to 95ºC at a speed of 6ºC/min, and then held at that temperature (holding) for 5 minutes. After the heating phase is completed, the starch paste is passed through the cooling phase that is the temperature is lowered from 95ºC to 50ºC at a speed of 6ºC/min, and then maintained at that temperature for 2 minutes. The RVA 4800 (Perkin Elmer, USA) instrument plots the gelatinization profile curve as a relationship of the value of viscosity (cP) on the y - axis with changes in temperature (ºC) during the heating and cooling phases on the x - axis.

Morphology of Starch Granules

i. Using polarizing microscope: This was done according to the method described by Xu *et al.* [12]. The form of starch granules BCSF and UCSF was observed using a polarizing microscope (Olympus Optical Co. Ltd, Tokyo, Japan) equipped with a camera. Flour suspension was made by mixing 1 g of flour with 15 ml of water. The preparations were seen at magnifications of 200 x and 400 x.

ii. Using Scanning Electron Microscope (SEM): It was carried out using the method of Airul *et al.* [13]. The sample BCSF and UCSF was glued on top of the sample container (specimens stub) using silver double-sided adhesive. The sample BCSF and UCSF was then coated with Au using the Hitachi E 102 Ion Sputter (Tokyo, Japan). The structure of BCSF and UCSF starch was observed on the monitor screen using a 1500 x magnification scale Hitachi S 2400 Scanning Electron Microscope (Tokyo, Japan). The observations were then photographed using a digital camera.

Determination of proximate composition

Moisture: The aluminum dish is dried in an oven (Shimidzu, Japan) at 105ºC for 15 minutes, then cooled in a desiccator for 10 minutes. The cup is weighed using analytical balance (Mettler Toledo-ML204). Amount 1-2 gram BCSF and UCSF sample is put in a cup, then it weighed with analytical balance (Mettler Toledo-ML204). The glass containing the sample was dried in an oven (Shimidzu, Japan) at 105ºC for 3 hours. Then the glass containing the sample is cooled in a desiccator, then it weighed until a constant weight is obtained [14].

$$\text{Moisture content (\%)} = \frac{Sample\ weight\ before\ drying\ (gram)}{Lose\ weight\ after\ drying\ \ (gram)}\text{x}100\%$$

Ash: The gray cup is dried in oven (Shimidzu, Japan) (105ºC,15 minutes), then it cooled in a desiccator. The blanched canistel seed flour (BCSF) and unblanched canistel seed flour (UCSF) as much as 2-3 grams is weighed in a cup, then made first in the smoke chamber until it does not emit smoke again, after that it is put into the Muffle Furnace Cat No STM-18-12 (Sitoho Lamsukses, Indonesia). Graying is carried out in a furnace at a maximum temperature of 550ºC for 4-6 hours until a perfect graying formed white ash. The cup containing the sample is cooled in a desiccator, then it weighed with an analytical balance to a constant weight [14].

$$\text{Ash content (\%)}= \frac{(sample\ weight + cup\ after\ graying(gram))-empty\ cup\ weight\ (gram)}{sample\ weight\ before\ graying\ (gram)}\text{x } 100\%$$

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Protein: Protein analysis consists of three stages: destruction, distillation and titration. The BCSF and UCSF samples were weighed as much as 2 grams, put into a **kjeldahl** flask (Iwaki, Japan). Next, the sample was added 1.9 ml of K_2SO_4 (Merck), 40 ml of HgO (Merck) and 2.0 ml of H_2SO_4 (Merck) then it was boiled until the liquid was clear. The sample is transferred to a distillation apparatus. Kjeldahl flask (Iwaki, Japan) is washed with 2 ml of water, then put into a distillation apparatus and 10 ml of NaOH (Merck) is added. Under the condenser is placed an erlenmeyer containing 5 ml of H_3BO_3 (Merck) solution. After that the sample is diluted to 50 ml and titrated with 0.02 N HCl until the color changes to gray [14].

$$\text{Protein content (\%)} = \frac{(HCl - Blanko)ml\ x\ \ N\ HCl\ x 14.007}{weight\ sampel\ (mg)} \text{ x 100\% x 6.25}$$

Fat: The fat flask to be used in the Biobase Soxhlet Extractor Automatic Fat Analyzer (Qingdao, China) is dried in the oven (Shimidzu, Japan), then cooled in a desiccator then weighed. Filter paper Whatman 42 (circles 125mm, pore size 2.5 µm) casings containing samples with cotton are dried at 80ºC for ± 1 hour. The paper sleeve is inserted in the Biobase Soxhlet Extractor Automatic Fat Analyzer (Qingdao, China) which has been connected to a fat pumpkin. Fat extraction with hexane is done for ± 6 hours. Next, a fat flask containing extracted fat is heated in an oven at 105°C. After that it is cooled in a desiccator, then it weighed until the weight remains [14].

$$\text{Fat content (\%)} = \frac{sample\ weight\ (gram) - weight\ of\ fat\ flask\ before\ extraction\ (gram)}{weight\ of\ fat\ flask\ after\ extraction\ (gram)} x\ 100\%$$

Carbohydrate: Carbohydrate levels are calculated using the formula:
Carbohydrate Content (%) = 100% - (protein + fat + water + ash content)
Starch: BCSF and UCSF samples were hydrolyzed with 80% ethanol (Merck) in waterbath. Then the precipitate was separated and hydrolyzed again with 9.2 N $HClO_4$ (Merck) three times and neutralized again with 1 N NaOH. Subsequently, it reduced by Cu and Nelson reagents. Starch content of BCS and UCSF was measured by spectrophotometer UV visible Shimadzu UV-1601 (Tokyo, Japan) at a wavelength of 500 nm [14].

Amylose: Amount of 100 mg BCSF and UCSF was placed in a test tube then added 1 mL of 95% ethanol (Merck) and 9 mL of NaOH (Merck) 1 N. The mixture was heated in boiling water to form a gel, then transferred to a 100 mL measuring flask. The gel is added to water and shaken, then added to water to 100 mL. A total of 5 mL of solution was put into a measuring flask and added with 1 mL of 1 N acetic acid (Merck) and 2 mL of iodine solution (Merck). The solution is fixed to 100 mL then shaken and left for 20 minutes. The intensity of the blue color formed was measured by spectrophotometer UV visible Shimadzu UV-1601 (Tokyo, Japan) at a wavelength of 625 nm [14].

Amylopectin (*by difference*): Amylopectin was calculated using the formula:
Amylopectin (%) = starch content - amylose content

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Data analysis
The effect of blanching treatment on the physicochemical characteristics of Canistel seed flour was analyzed by Paired T-test at a significance level of 5% using Minitab. Variables analyzed by Paired T-test data analysis results.

RESULTS AND DISCUSSION

Physical Properties of Canistel Seed Flour

Yield production and degree of whiteness
The results of the analysis of the yield production and degree of white BCSF and UCSF can be seen in Table 1. Yield production was higher in blanched seed flour (41.61%) than in unblanched seed flour (37.47%). The results of the Paired T-Test significance level of 5% show the value of yield production for UCSF is significantly different from the BCSF. Ogunlade *et al.* [15] reported that the higher the moisture content, the higher the yield produced. This is in accordance with the results of the calculation of yield production on Canistel seed flour. The BCSF has a higher moisture content which is 9.77% compared to UCSF that is 8.59%. Yield production of BCSF was higher than UCSF.

Paired T-test results of significance level of 5% showed that the value of the degree of white in UCSF was significantly higher compared to that of BCSF (Table 1). These results are consistent with research on the white degree of red bean seed flour [16] and suweg flour [17]. The value of the degree of white in red bean seed flour produced from the treatment without heating is higher when compared to the heating treatment [16]. The blanching process can cause gelatinization of starch, damage the structure of starch granules, and denaturation proteins in food [7,8]. Flour subjected to blanching process has a lower level of brightness (white degree) compared to flour without blanching process [7,8]. Arici *et al.* [18] reported that carbohydrate and protein levels play a role in the formation of non-enzymatic brownish reactions that affect the whiteness and color of the final flour product.

Starch gelatinization profile
The value of each RVA parameter shows different results (Table 2). The RVA profile of UCSF and BCSF also showed differences (Figures 3A and 3B). This shows that blanching at 80°C for 10 minutes affects the gelatinization profile of Canistel seed flour.

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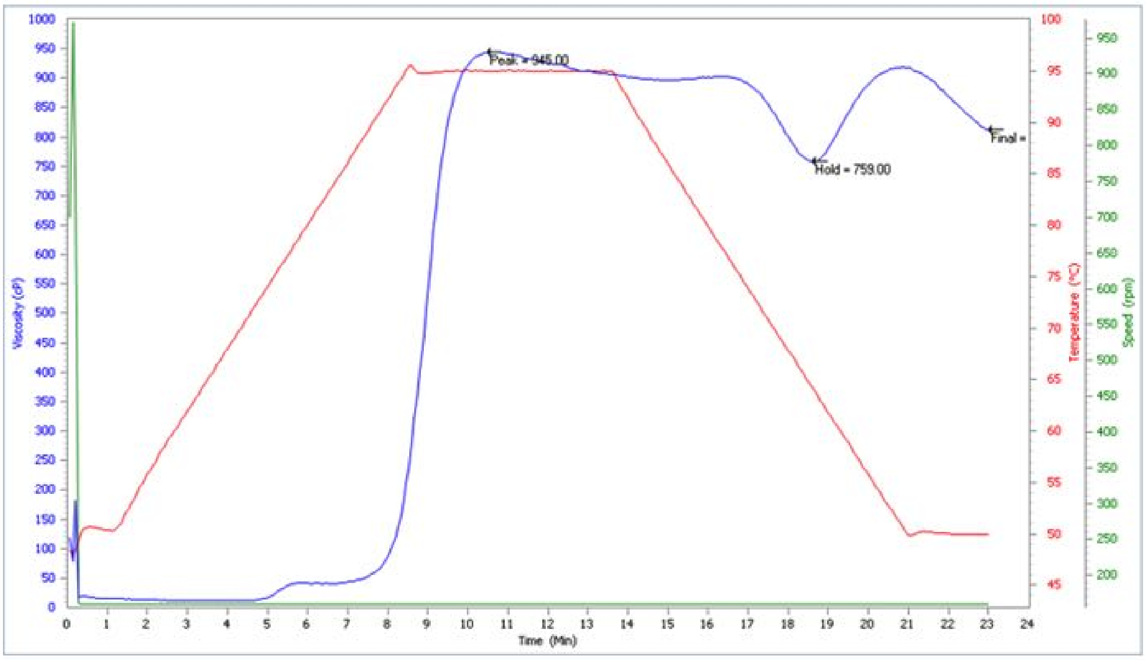
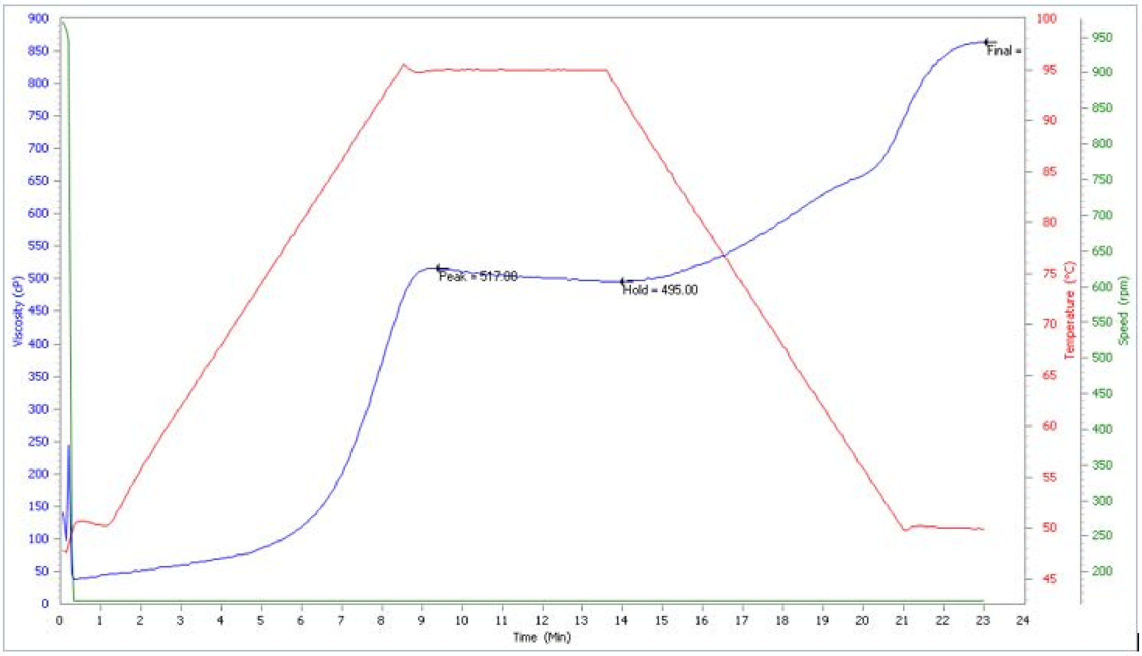
	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time	Pasting Temp
"STANDARDDUA20181107"	945	759	186	812	53	10.47	93.5



(A)

	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time	Pasting Temp
"STANDARDDUA20181107"	517	495	22	864	369	9.33	err



(B)

Figure 3: RVA profile of (A) Unbleanched Canistel Seed Flour (UCSF), (B) Blanched Canistel seed flour (BCSF)

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The results of gelatinization profile analysis showed that UCSF had a higher peak viscosity (945 cP) compared with BCSF (517 cP) (Table 2). These results indicate that UCSF has the ability to develop starch granules that are larger than BCSF. Tie *et al.* [20] reported that amylopectin is a starch component responsible for granule development. The peak viscosity value of UCSF is higher than that of BCSF because of its higher amylopectin content. Amylopectin content in UCSF was 33.35%, while that with BCSF was 31.69%. Amylopectin is stimulating the process of blooming (puffing). Therefore, if a material has a high content of amylopectin, it has a greater swelling ability compared to a material that has lower amylopectin content [19]. Peak viscosity is associated with the maximum swelling power level of starch granules in intact condition.

The unblanched canistel seed flour (UCSF) had higher heat viscosity (759 cP) compared to blanched canistel seed flour (BCSF) (495 cP) (Table 2). The blanched canistel seed flour (BCSF) experienced significant changes in viscosity after the heating process. This shows that BCSF is not resistant to heating because the value of heat viscosity is getting lower.

The unblanched canistel seed flour (UCSF) had a higher breakdown viscosity (186 cp) value compared to blanched canistel seed flour (BCSF) (22 cP) (Table 2). Breakdown viscosity shows the stability of starch granules during heating and stirring. These results are consistent with the study of Tie *et al.* [20] who reported that the gelatinization profile of native starch was characterized by a high peak viscosity value followed by a sharp decrease in viscosity during heating. Lee *et al.* [21] reported that an increase in the breakdown viscosity value showed that starch was increasingly resistant to heating and stirring. These results indicate that the BCSF is less resistant and less stable in the heating and stirring process.

The unblanched canistel seed flour (UCSF) (812 cP) had a lower final viscosity value than blanched canistel seed flour (BCSF) (864 cP) (Table 2). Amylose content in BCSF was higher than UCSF. Amylose content in BCSF was 24.79% while in UCSF it was 23.99%. This is consistent with the study of Lin *et al.* [22] who reported that final viscosity was significantly positively correlated with amylose content in flour. The higher the starch amylose content, the higher the final viscosity. Jane *et al.* [23] reported that linear molecules and strong associations between amylose molecules maintain the integrity of the granules making them more resistant to heating and stirring. Final viscosity shows the ability of starch to form a thick paste or gel after heating and cooling to shear forces that occur during stirring [13].

The blanched canistel seed flour (BCSF) had a higher setback viscosity value (369 cP) than unblanched canistel seed flour (UCSF) (53 cP) (Table 2). These results indicate that BCSF is more easily subjected to retrogradation than UCSF. The blanched canistel seed flour (BCSF) has a more stable gel when compared to the gel formed by UCSF. Samples with high amylose have the stability and durability to remain intact in high heating, and have strong retrogradation properties, so that after cooling the paste formed becomes strong and does not break easily. A high setback viscosity value will produce high cohesiveness and hardness [24]. Retrogradation is the formation of microcrystalline

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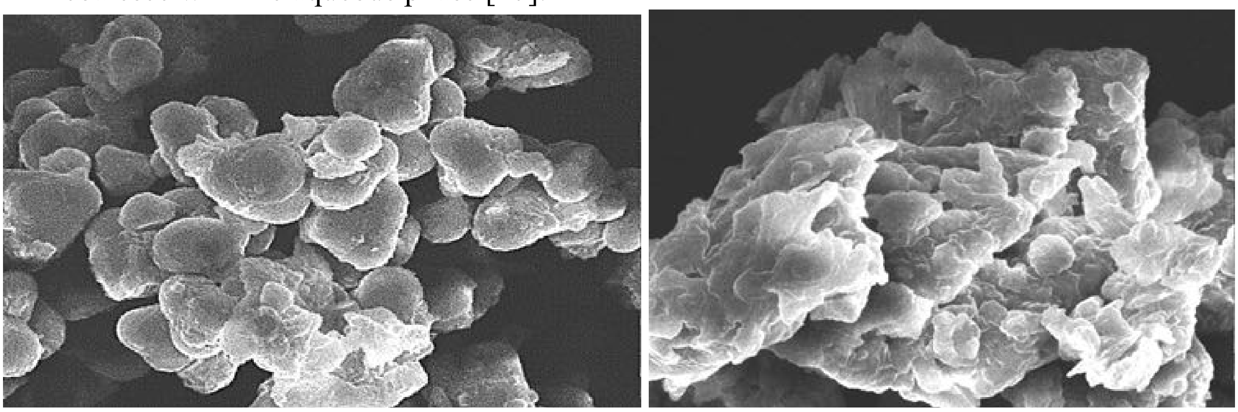
tissue from amylose molecules that bind back to each other or by branching amylopectin outside the starch granules after the paste has cooled.

The unblanched canistel seed flour (UCSF) had a peak time of 10.47 minutes and thickening or gelatinization temperature at 93.5°C. Meanwhile, BCSF had a peak time of 9.33 minutes, but the thickening temperature was not detected by the RVA. The peak time is the time of cooking the starch paste. The peak time of UCSF was higher than the BCSF. These results indicate that UCSF has a starch paste cooking time slower than BCSF. This causes UCSF to coagulate more slowly and reach its peak viscosity. Gelatinization temperature is the temperature at which viscosity increases due to swelling of the starch granules. The higher temperature of gelatinization indicates that starch requires longer cooking time and greater thermal energy. High gelatinization temperatures indicate the stability of starch molecular crystals [25].

Morphology of Starch Granules Canistel Seed Flour
Scanning Electron Microscope (SEM)
The appearance of starch granules on UCSF (Figure 4) shows a tight starch granule. The appearance of starch granules on BCSF (Figure 4) shows the starch has changed the shape of starch granules to be broken or damaged. These results indicate that blanching treatment influences the morphology of starch granules. The unblanched canistel seed flour (UCSF) starch granules are naturally white, shiny, odorless, and tasteless. Microscopically the UCSF starch granules are formed by molecules that form a thin layer that is arranged centrally. The physical structure of the flour, the granule form, influence the properties of starch in its applied. Starch heating caused the development of granules, starch polymers came out of the granules, and finally the starch granules burst [26]. Bilbao-Sainz *et al.* [26] reported that with the heating temperature rising above the gelatinization temperature, starch granules will expand and are no longer able to hold water. The starch granules will rupture and the amylose and amylopectin molecules will coalesce with the aqueous phase [27].



(A) (B)

Figure 4: The appearance of starch granules from SEM analysis on (A) Unblanched Canistel Seed Flour (UCSF), (B) Blanched Canistel Seed Flour (BCSF)

Polarizing Microscope
Morphological analysis of starch granules using polarization microscopy aims to determine differences in the shape of starch granules and the nature of birefringence from

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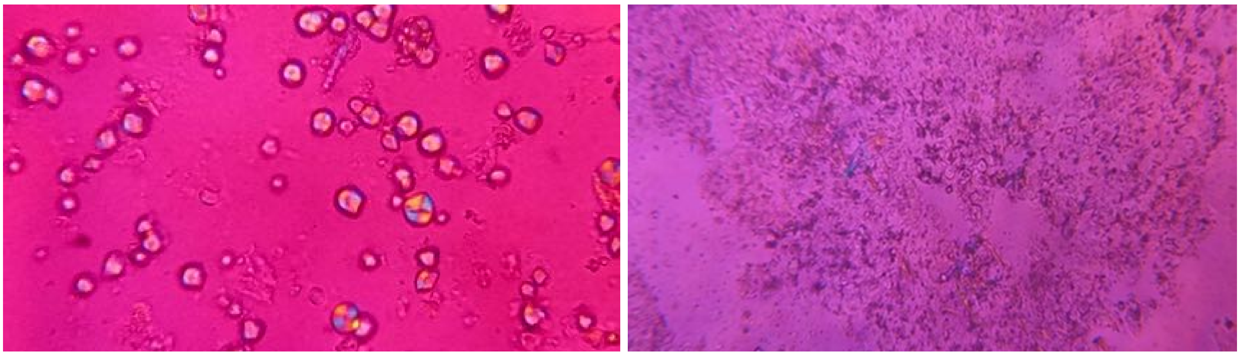
UCSF and BCSF. This appearance of birefringence shows that UCSF has not undergone gelatinization. Birefringence is the nature of starch granules that can reflect polarized light so that under a microscope the polarization forms blue and yellow fields [26].



(A) (B)

Figure 5: The appearance of Canistel seed flour granules (A) Unblanched Canistel Seed Flour (UCSF), (B) Blanched Canistel Seed Flour (BCSF)

The formation of blue and yellow color is caused by the refractive index differences in starch granules which are affected by the crystalline and amorphous areas of the starch. The nature of birefringence is also known as the maltose cross pattern in starch that occurs due to intersection of blue and yellow fields [27]. The unblanched canistel seed flour (UCSF) showed that the starch granule still had birefringence appearance (Figure 5). Starch granules are round and intact. This shows that the granule structures of the UCSF have not yet been damaged. Observation of the morphology of starch granules using polarization microscopy on BCSF showed the starch granule was not visible and there was no appearance of birefringence (Figure 5). The loss of birefringence indicates that starch has damaged starch granules due to heating or hydrolysis [26]. This shows that Canistel seed flour has been gelatinized at 80°C. High temperature heating can change starch gelatinization so that more damaged starch granules will be formed [27].

Chemical Properties of Canistel Seed Flour

Moisture content

The moisture content of UCSF was 8.59% while that of BCSF was 9.77%. Moisture content UCSF and BCSF according to quality requirements of wheat flour according to SNI 01-3751-2018 is a maximum of 14.5% [28]. Paired T-test results at a significance level of 5% indicate that the moisture content of UCSF was significantly different from BCSF (Table 3). These results are similar to the research of Kusumawati *et al.* [29] that the moisture content of flour carried out by the blanching process showed an increase. Blanching process causes the starch contained in the material to swell, hence the ability to absorb water is high. Blanching process with high temperature can change the gelatinized starch so that the damaged starch granules will be higher. Naibaho *et al.* [30] reported that the moisture content of flour with heating treatment was higher than flour without heating treatment. An increase in moisture content is caused by boiling which can cause the particles to become more porous thereby increasing the ability of water absorption after drying which can further increase the moisture content contained in the material. Moisture content is one of the most important characteristics of canistel seed

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flour because the activity of water (Aw) can affect the appearance, texture, and taste of food. Moisture content in canistel seed flour also determines the freshness and shelf life of the food. High moisture content makes it easy for bacteria, molds, and yeast to grow so that there will be changes in the quality of canistel seed flour.

Ash content

The ash content of UCSF was 2.15% while the ash content of BCSF was 1.99%. Ash content in UCSF and BCSF does not meet the quality requirements for wheat flour according to SNI 01-3751-2018. Quality requirements for ash content in wheat flour according to SNI 01-3751-2018 is a maximum of 0.070% [28]. Paired T-test results at a significance level of 5% showed that the ash content of UCSF was significantly different from that of BCSF (Table 3). This is in accordance with research by Kusumawati *et al.* [29] that blanching caused mineral loss due to dissolution. Water-soluble mineral components will be released during the blanching process. Naibaho *et al.* [30] reported that boiling treatment reduced ash content from flour. Significant reduction occurs due to dissolution of minerals into the immersion media which is accelerated by heating. Ash content associated with minerals of an ingredient. Minerals are classified as inorganic nutrients also called ash elements in food because if food is burned organic elements will disappear and the remaining inorganic material ash consists of mineral elements.

Fat Content

The fat content in UCSF was 5.73% while that of BCSF was 6.73%. Paired T-test results at the significance level of 5% showed the results were not significantly different (Table 3). These results indicate that blanching treatment has no effect on fat content in Canistel seed flour.

Protein Content

Protein content in UCSF was 10.30% while that in BCSF was 9.92%. Quality requirements for protein content in wheat flour according to SNI 01-3751-2018 is a minimum of 7.0% [28]. The results of this study indicate that the protein content of UCSF and BCSF meets the quality requirements of wheat flour according to SNI 01-3751-2018. Paired T-test results at significance level of 5% showed that the protein content of UCSF was significantly different from that of BCSF (Table 3). These results are similar to the study of Naibaho *et al.* [30] who reported that the blanching process caused a decrease in protein content due to protein denaturation in flour. UCSF will have higher protein content than BCSF.

Carbohydrate, Starch, Amylose and Amylopectin Levels

Carbohydrate content in UCSF was 73.24%, while carbohydrate content in BCSF was 71.58%. Paired T-test results at significance level of 5% showed no significant difference (Table 3). These results indicate that blanching treatment did not significantly influence the carbohydrate content of Canistel seed flour. The starch content in UCSF was 56.88%, while that of BCSF was 56.71%. Paired T-test results of starch levels at 5% significance level showed no significant difference (Table 3). This shows that blanching treatment has no effect on starch content in Canistel seed flour.

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Amylose content in UCSF was 23.99% and BCSF was 24.79%. Amylopectin content in UCSF was 32.89% and BCSF was 31.93%. The results of the Paired T-test at a significance level of 5% showed that the levels of amylose and amylopectin in UCSF were significantly different from the amylose and amylopectin content in BCSF (Table 3). Amylose plays a role in the gelatinization process and largely determines the characteristics of starch paste. Starches that have high amylose have greater hydrogen bond strength because of the large number of straight chains in the granules, thus requiring large energy for gelatinization [25]. Amylopectin is a large molecule with many branches and forms a double helix. When the starch is heated, some of the double helix fraction of amylopectin is stretched and released when a hydrogen bond is broken [31]. The presence of amylopectin in starch will reduce the tendency of starch to form a gel. Characteristics such as texture, viscosity, and stability are significantly affected by the level and molecular weight of amylose and amylopectin. Moorthy [25] reports that heat causes the starch molecules to vibrate, so that the α-1,6 glycosidic bonds will be broken first. This is due to the α-1,6 bond being more unstable than the α-1,4 bond. If the α-1,6 bond is broken, then the amylopectin molecule which has a branch chain will change its structure to amylose which has a straight chain. So with more and more α-1,6 bonds being broken, the number of amylose increases and the number of amylopectin decreases [25].

CONCLUSION

Blanching had a significant effect on the physical properties of Canistel seed flour; thus, yields were higher (41.6%) and chromatometric (colour) levels were lower (80.61). Pasting properties profile showed that BCSF has the ability to swell inspite of its small granules, easily retrograded, and thickens faster than UCSF. The blanching treatment improved the microstructure of the Canistel seed flour starch granules. Blanching can change starch gelatinization so that more damaged starch granules will be formed. Blanching significantly affected several chemical properties including moisture content, ash, protein, amylose, and amylopectin. Meanwhile, blanching had no significant effect on fat, carbohydrate, and starch content of Canistel seed flour. Campolay seed flour from Cipatat, Bandung has a water content and protein content that matches the quality requirements of wheat flour according to SNI 01-3751-2018.

Authors' contributions

LA, RHBS, TF and SM designed and conducted field research; SM and TF performed laboratory analysis; SM, LA, and TF conducted statistical analysis; RHBS and LA wrote the manuscript with inputs from all co-authors; RHBS had final responsibility for content. All authors read and approved the final manuscript.
[LA-Lia Amalia; RHBS-R. Haryo Bimo Setiarto; TF- Tiana Fitrilia; SM-S Masyrifah]
(Lia Amalia and R. Haryo Bimo Setiarto are the main contributors for this manuscript paper)

Conflict of Interest

There is no conflict of interest in this paper.

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Table 1: The results of the analysis of yield production and degree of whiteness on Unblanched Canistel Seed Flour (UCSF) and Blanched Canistel Seed Flour (BCSF)

Parameter	Unblanched Canistel Seed Flour	Blanched Canistel Seed Flour
Yield (%)	37,47[b]	41,61[a]
Degree of whiteness	91,08[a]	80,61 [b]

Note:* Different letters on row indicate significantly different at 5% level

Table 2: Starch gelatinization profile on Unblanched Canistel Seed Flour (UCSF) and Blanched Canistel Seed Flour (BCSF)

Parameter	Unblanched Canistel Seed Flour	Blanched Canistel Seed Flour
Peak viscosity	945,00 cP	517,00 cP
Heat viscosity	759,00 cP	495,00 cP
Breakdown viscosity	186,00 cP	22,00 cP
Final viscosity	812,00 cP	864,00 cP
Setback viscosity	53,00 cP	369,00 cP
Peak time	10,47 minutes	9,33 minutes
Pasting temperature	93,50°C	Not detected

Table 3: The results of chemical analysis on Unblanched Canistel Seed Flour (UCSF) and Blanched Canistel Seed Flour (BCSF)

Parameter	Unblanched Canistel Seed Flour	Blanched Canistel Seed Flour
Moisture (%)	8,59[b]	9,77[a]
Ash (%)	2,15[a]	1,99[b]
Fat (%)	5,73[a]	6,73[a]
Protein (%)	10,30[a]	9,92[b]
Carbohydrate (%)	73,24[a]	71,58[a]
Starch (%)	56,88[a]	56,71[a]
Amylose (%)	23,99[b]	24,79[a]
Amylopectin (%)	32,89[a]	31,93 [b]

Note: * Different letters on row indicate significantly different at 5% level

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