Effect of processing techniques on color and active components amount of sweet potato (Ipomoea Batatas l) flakes

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Abstract. Sweet potato processing is limited, such as flour, snacks, cystic, or chips. Flakes as pre-cooked meals are made through the stages of making pasta and drying. The purpose of this study was to optimize the production of sweet potato flakes at the stage of making pasta and drying. Making the pasta is done through techniques steamed or baked. Pasta drying using tools a drum dryer or cabinet dryer. As an indicator of optimization is the total of monomeric anthocyanins, β-carotene and color the resulting flakes. The results showed that the amount of anthocyanin monomeric flakes by using steam, and drum dryer (3.83 ± 0.03 mg CYE / g db), flakes by the technique of steam, and cabinet dryer (3.03 ± 0.02 mg CYE / g db), flakes with techniques bake, drum dryer (2.49 ± 0.05 CYE mg / g db), flakes with bake technique, cabinet dryer (1.98 ± 0.03 mg CYE / g db). The Color of purple sweet potato flakes produced through steamed techniques bright purple, while the color purple sweet potato flakes produced through techniques roast give a brownish purple color. The amount of β-carotene yellow flakes sweet potato with stages of cooking steamed, drum dryer (152±0.5 mg / Kg db), grilled drum dryer (136±0.4 mg / Kg db), flakes of yellow sweet potato with stages of roasted and cabinet dryer (140±0.8 mg / Kg db), and grilled stage with cabinet dryer (122±0.3 mg / Kg db). In conclusion sweet potato flakes production techniques through the stages of steam process, and used drum dryers have a number of anthocyanins or β-carotene bigger and brighter colors than the baked flakes techniques and used cabinet dryer.

1. Introduction
The average productivity of sweet potato (Ipomoea batatas L) Indonesia 123.29 kw / ha, with a total production of 2.196.033 tons. The average productivity of sweet potato in West Java 153.73 ku/ha, with a total production of 429 378 tonnes (BPS 2011). Flesh color of sweet potato grown in West Java, beige, yellow, orange and purple. Purple sweet potato contains carbohydrates, minerals, vitamins, anthocyanins, dietary fiber and has a glycemic index (Glycemic Index) is low. In terms of its chemical composition, yams potentially be used as a source of carbohydrates, vitamins, minerals, and antioxidants such as phenolic acids, tocopherols, anthocyanins, and β-carotene [1]. Colors and varieties of yams determine the level and profile of the content of phenolics such as anthocyanins and carotenoids. Phenolics present in sweet potatoes is chlorogenic acid which is an ester of cinnamic acid and acid quinat. Chlorogenic acid includes three isomers of mono caffeoylquinic acid (CQA): 3CQA (neochlorogenic acid); 4-CQA (cryptochlorogenic acid); and 5-CQA (chlorogenic acid); and three dicaffeoylquinic acids: 3,5-diCQA, 3,4-diCQA, and 4.5-diCQA (isochlorogenic acid) [2]. Anthocyanins are red dye, purple and blue fruits, vegetables, grains cereal / rice and flowers. Anthocyanin dissolves in water, the phenolic group of the group of flavonoids. Anthocyanins are dye on the flowers, leaves, tubers, fruits and vegetables that give ping color, red, blue, purple influenced by pH. Anthocyanins have
antioxidant activity [3][4][5][6][7]. Anthocyanin content in sweet potatoes were extracted at a temperature of 80 °C by using an acidified methanol (3.3% w/v) 186, highest of cyanidin, 3-glucoside / 100 g wb (wet base). Carotenoids is a dye found in plants that plays an important role as a pro-vitamin A. Sweet potatoes are yellow or orange contains β-carotene higher than others [8][9][10]. Sweet potatoes are very prospective to serve as food for health (functional food) [11].

Some research suggests that the phytochemical content in sweet potatoes have antioxidant activity or has the ability to capture free radicals so as to provide a good influence on human health [12][1]. Red sweet potato cultivars are grown in the Andean has antioxidant activity and phenolic content which is higher than blueberries, fruits with high antioxidant content [3]. The content of total phenolics of four varieties of sweet potatoes ranged from 45 to 103 mg gallic acid equivalent (GAE) / 100 g fresh weight [4]. The content of phenolics, anthocyanins, carotenoids yams correlated with antioxidant activity.

According to [13] cooking techniques can reduce the amount of phenolics content of for the o en, and for engineering fried oiled. Losing highest phenolic content sequentially boiled> fried> saute-steamed> microwave - oven roasted with. [14][15] found that the amount of anthocyanin reduced by nearly half when steamed and only slightly reduced when urned. Losing the content of trans β-carotene with boiled technique more than urned. The content of trans β-carotene is more abundant than the cis-β-carotene were approximately 0.6 to 1.3% [16]. Sweet potato storage at cold temperatures cause increased phenolic content [17]. Caffeoyl-sucrose derivatives, 6-O-caffeoyl- (β-D fructofuranosyl- (2-1)) - a-D-glucopyranoside (FCG), was found to increase during storage 15oC [2]. Carotenoid content decreased during storage due to autoxksidasi ecause the pace of decline associated with β-carotene content level of water and oxygen. Treatment processes can decrease the amount of anthocyanins present in sweet potatoes [18][15][19][6].

Sweet potatoes have a semi perishable nature. Within one month of storage, sweet potato sprout leaves. Yams are widely used as raw material for the manufacture of chips, dodol, flour and keremes. Utilization of sweet potato as a food inggridient still limited. Unlike the potato that has been processed into various food ingredient such as mash potato or potato flakes. Flakes potato is a potato-based food ingredient that is widely used both by households and catering industry, as materials for French fried potatoes, or potato chips [20]. The nature of sweet potato are relatively easily damaged, it needs to make other preparations which have a longer shelf life as sweet potato flakes. Sweet potato flakes made from raw sweet potato, cooked, prepared pasta and dried using a dryer.

Thus we see the need for a food ingredient made from yams that have a longer shelf life. In line with the diversification program of food, sweet potatoes can be processed into flakes of sweet potato. Sweet potato flakes are dried dosage form of flakes are made through the process of making pasta and drying. Manufacture of pasta can be done through a technique boiled, broiled, or grilled. According to [15] the amount of anthocyanin reduced by nearly half when steamed and only slightly reduced when baked. Thus in this study will be assessed regarding the optimization of the production of sweet potato flakes as diversification of sweet potato processing. The purpose of this study was to optimize the process of making sweet potato flakes, through the technique of making pasta with steamed or grilled and pasta drying technique using a drum dryer or dryer cabinet, as diversification of sweet potato processing.

2. Methods and Materials

2.1. Materials
The tools used UV / VIS Shimadzu UV-2450, Chromameter Minolta CR 310, Steamer, Oven, drum dryer and glassware. Materials used are purple sweet potato planting time - + 5 months of farmers in Bandung Regency Banjaran. Methanol, HCl, KCl, Sodium acetate PA from Merck.

2.2. Sample Preparation
To make sweet potato flakes made by way: as much as 5 kg sample of shelled, washed in running water, cut with a thickness of 3 cm. Pieces sample steamed for 15 minutes or baked at a temperature of 150 °
C oven for 60 minutes. Pieces of samples that have been steamed or baked entered grinder, homogenized, and then dried with a dryer drum 141 oC 3.75 bar rotation speed of 1 rpm. The dried samples (Flakes) formed a smaller size. Flakes sweet potatoes are stored in plastic bags and stored in the dark at room temperature up to further analysis [20].

2.3. _Anthocyanin extraction_ [21][22][23]
As many 10g sweet potato powder was extracted with 320 mL of acid- methanol solution of 12% HCl (HCl, 1.5 mol / L in methanol) is inserted into the thermostatic water bath of 50°C for 60 minutes. Then centrifuged at a speed of 4000 rpm for 15 minutes. The supernatant was collected and filtered using a vacuum filter. The organic solvent is evaporated using a rotary evaporator temperature of 40°C to obtain the anthocyanin extracts concentrated. Concentrated extract stored in dark bottles stored at -20°C until used for analysis.

2.4. _Analysis of total monomeric anthocyanin_ [23]
The content of total monomeric anthocyanin is measured by pH difference method [24] as modified by [23]. This method is based on the transformation of the structure of anthocyanin when the pH changes. 1 mL sample is introduced into a 5 mL volumetric flask and then added a solution of potassium chloride buffer (0.025 M) pH 1 up to 5 mL volume. A total of 1 mL of sample is introduced into a 5 mL volumetric flask else then added a solution of sodium acetate buffer (0.4 M) pH 4.5 up to 5 mL volume. Then the flask was placed in a dark place for 1 hour. Absorbance of each solution after berkesetimbangan measured using a spectrophotometer at a wavelength of maximum absorbance and 700 nm with distilled water blank. Absorbance is calculated as:

\[ \text{Abs:} (A_{\lambda \text{vis-max}}-A_{700})_{\text{pH}1.0}(A_{\lambda \text{vis-max}}-A_{700})_{\text{pH}4.5} \]  

with a molar extinction coefficient of 26900 to sianidin-3-glucoside. Total monomeric anthocyanin is calculated and expressed as mg equivalent sianidin-3- glycoside / 100 grams of flakes. The equation used to calculate the number of monomeric anthocyanin is:

\[ \text{Antosianin monomerik (CyE, mg/L)} : \]  

\[ \text{Abs:} (A_{\lambda \text{vis-max}}-A_{700})_{\text{pH}1.0}(A_{\lambda \text{vis-max}}-A_{700})_{\text{pH}4.5} \]

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\[ \text{Antosianin monomerik (CyE, mg/L)} : \]  

\[ \text{A: absorbance, BM: anthocyanin molecular weight (449.2 g / mol), FP dilution factor, } \varepsilon : \text{ molar absorbance sianidin -3-glucoside (26900 L mol }^{-1} \text{ cm }^{-1}), L \text{ length cuvette cell (1 cm), all measurements were performed 3 repetitions.} \]

3. _Result and Discussion_

3.1. _Production of Sweet Potato Flakes_
Production of sweet potato flakes made through the stages of stripping the skin, making of sweet potato paste, and drying the pasta. Stripping the skin can be done by using a paring knife or abrasion. Sweet potato pasta-making is done by cooking fresh sweet potatoes with techniques steamed, boiled or roasted. According to [13] cooking techniques can reduce the amount of phenolics content of for the oen, and for engineering fried oiled. Losing highest phenolic content sequentially boiled> fried> saute - steamed> microwave - baked in an oven [14]. [15] found that the amount of anthocyanin reduced by nearly half when steamed and only slightly reduced when baked.

Figure 1 shows the color purple sweet potato flakes with the technique of making the pasta through the stages of steamed or roasted. The resulting paste is then dried using a drum dryer and the dryer cabinet. Figure 1A is an image of purple sweet potato flakes produced through the process of making pasta through stages pasta steamed and then dried with a drum dryer. Figure 1B is a purple sweet potato
flakes image generated through the process of making pasta through stages pasta steamed and then dried with a dryer cabinet. Figure 1C is a purple sweet potato flakes image generated through the process of making pasta with grilled stage and then dried pasta with a drum dryer. Figure 1D is a purple sweet potato flakes image generated through the process of making pasta with grilled stage and then dried pasta dryer cabinet. The water content of purple sweet potato flakes ranged from 6% - 7%. The yield of sweet potato flakes produced is ± 25%. The water content of fresh sweet potatoes about 67%, and the amount of sweet potato skin around 8-10%.

Fresh sweet potato cooking process is intended to get the texture of soft sweet potato to facilitate the making of pasta. Sweet potato paste can be made by using a grinder, mixer or crushed mixed manually using a hand. Sweet potato pasta drying process can be performed using an oven, dryer cabinet or with a drum dryer. Drying using a drum dryer produces purple sweet potato flakes subtle shine bright. Drying pasta using cabinet dryers produce purple sweet potato flakes darker. sweet potato flakes with the stages of cooking techniques and techniques steamed roast sequentially shown in Figure 1.

3.2. Total Anthocyanins of Purple Sweet Potato Flakes
Anthocyanin measurement method sweet potato flakes made by the method of pH differences. Anthocyanins are dye pink, red, blue, purple discolored influenced by differences in pH. At acidic pH conditions of the majority of anthocyanins are in the form of cations flavilium that gives the red color. At alkaline pH state of the majority of anthocyanin is in the form quinonoidal which gives a blue color. Besides anthocyanin can equilibrate form pseudobase or calcon giving colorless effect.
Anthocyanin extraction carried out in an acidic state. Anthocyanins are water soluble dye. From several studies optimum conditions for extraction of anthocyanin is to use methanol acidified with HCl 12% (1.5 M HCl in methanol), with a sample size - + 100 mesh with a ratio of solids: solvent 1: 32. Suspension samples with solvent stirred by using stirrer speed of 4, and the temperature of the room. The suspension is then stored in a rocking water bath at 50 °C for 60 minutes. Then the sediment is separated between the supernatant by using centrifuge with a speed of 4000 rpm for 15 minutes at room temperature. Supernatant was then filtered through Whatman filter paper No. 1 and anthocyanin extract was concentrated by rotary evaporator 4 speed, 40oC. The yield of the concentrated extract of anthocyanin ± 23%. Each 1 mL of concentrated anthocyanin extract is inserted each into a 5 mL volumetric flask which is different, then each flask is added buffer CH3COONa KCl 0.4 M and 0.025 M. The solution was mixed, allowed to stand 1 hour then measured using a spectrophotometer at a wavelength of maximum (530 nm).

Measurement of the total number of monomeric anthocyanin in this study using a pH difference. The total amount of anthocyanin purple sweet potato flakes and β-Carotene of orange purple sweet potato showed in Table 1. Table 1 showed that stages of making pasta with steam and used drum dryer, total anthocyanin and β-carotene higher than stages of making pasta with bake and used cabinet dryer. According to [18] the amount of anthocyanins from purple sweet potato several genotypes ranged from 0.02 to 2.10 mg / g wet basis. According to [25] the highest of sweet potato anthocyanin 158 mg / 100 g wet base and 418 mg / 100 g wet basis [6]. The number of purple sweet potato anthocyanin 138 mg / 100 g dry basis. This research results contrary to the opinion of [15] which states roasting process (40-50 minutes the temperature of 200 oC) to lose a little of the total anthocyanin compared with steamed techniques (10 min 210 oC) which can lower half of the amount of anthocyanin. This difference is due to differences in sample preparation techniques and time, the temperature used in the different cooking techniques. Preparation of the samples in this study, yams undergone stripping the skin first, and conducted by [15] do not explain a process of stripping the skin.

| Table 1 Quantity of anthocyanin monomeric and β-carotene of flakes sweet potato |
|-----------------------------------------------|---------------------------------|--|--------------------------|
| Stages of making Pasta | Tools of drying | Anthocyanin (mg CYE/g db) | β-carotene (mg/Kg db) |
| Steam | Drum dryer | 3.83 ± 0.03 | 152 ± 0.5 |
| Steam | Cabinet dryer | 3.03 ± 0.02 | 136 ± 0.4 |
| Bake | Drum dryer | 2.49 ± 0.05 | 140 ± 0.8 |
| Bake | Cabinet dryer | 1.98 ± 0.03 | 122 ± 0.3 |

CYE : Cyanidin-3-glucoside Equivalent db : dry basis

3.3. Total β-Caroten of Yellow Sweet Potato Flakes
The water content of sweet potato flakes with grilled engineering 7% and the water content of sweet potato flakes technique is 6% randem steamed sweet potato flakes produced was 25%. The water content of fresh sweet potatoes about 67%, and the amount of sweet potato skin around 8-10%. From the results of this study, the amount of β-carotene and color flakes sweet potato yellow stages of ripening (A) steam dryer drum, (B) grilled drum dryer, flakes of sweet potato yellow stages of roasted dryer cabinet (C), and the grilled dryer cabinet (D) showed in Table 1 and Figure 2.
According to [13] cooking techniques can reduce the amount of phenolics content for the oven, and for engineering fried oiled. Losing highest phenolic content sequentially boiled > fried > saute > steamed > microwave - oven roasted with. [14]. Losing the content of trans β-carotene with oiled technique more than turned. The content of trans β-carotene is more abundant than the cis-β-carotene which is about 0.6-1.3% [16]. Sweet potato storage at cold temperatures cause increased phenolic content [17]. Caffeoyl-sucrose derivatives, 6-O-caffeoyl-(β-D-fructofuranosyl- (2-1)) - α-D-glucopyranoside (FCG), was found to increase during storage 15°C [2].

Carotenoid content decreased during storage due to autooxidasi because the pace of decline associated with β-carotene content level of water and oxygen. Sweet potatoes contain trypsin inhibitors from 0.2 to 43.6 IU / 100 g. Trypsin inhibitor can shut down the enzyme active site of trypsin that it can not bind with the substrate. Sweet potatoes contain stakiosa that can cause flatulence effects. Stakiosa fermented by the bacteria present in the gut to form H-2 gas and CO2. Sweet potatoes contain trypsin inhibitors from 0.2 to 43.6 IU / 100 g. Trypsin inhibitor can shut down the enzyme active site of trypsin that it can not bind with the substrate.

Varieties of sweet potato with carotene content higher associated with a water texture, pumpkin flavor and orange color while the varieties of sweet potatoes with carotenoid content low have a characteristic sweet tasting, yellow color, creamy color, starchiness, hard texture, coarse texture and fibrous texture [26]. This is in line with the opinion reported that the varieties of sweet potatoes with orange flesh has a flavor that is approaching the yellow vegetables such as pumpkin.

4. Conclusion

The conclusion from this study is the technique of making the pasta is steamed in the best technique in the manufacture of sweet potato flakes which can maintain the amount of β-carotene and anthocyanin highest. Number antosinin purple sweet potato flakes highest is the technique of making pasta by means steamed and dried pasta using drum dryers. The amount of β-carotene is the yellow sweet potato flakes highest is the technique of making pasta by means steamed and dried pasta using drum dryers.

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