Effect of blanching pre-treatment on colour and anthocyanin of dried slice purple sweet potato (*Ipomoea batatas* L)

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Abstract. Purple sweet potato (*Ipomoea batatas* L) contains many acylated anthocyanins which are beneficial for human health. Purple sweet potato roots are easily damaged due to the high water and nutrient content. To extend the shelf life of purple sweet potatoes can be done by a drying process. The drying process can affect the colour and amount of anthocyanin. The purpose of this study was to analyse the effect of blanching on colour and the amount of anthocyanin of dried slice purple sweet potato. The blanching method studied was steam blanching with a temperature of 70°C-80°C and blanch with boiling water 90°C – 98°C for 2 minutes. To measure the amount of anthocyanin by the pH difference method and measure colour using the chromameter. The results showed that the steam blanching technique produced a higher colour and amount of anthocyanin of dried chips purple sweet potato compared to blanching boiling water. This is because Anthocyanin dissolves in water. The conclusion is to get the colour and the relatively high amount of anthocyanin in dried pieces of purple sweet potato can be done by steam blanching. The implication to prevent browning process when making dried slice purple sweet potato can do steam blanching.

1. Introduction

Purple sweet potato (PSP) is a source of anthocyanin, which contains more than 98% of the acylated anthocyanins from the concentration of anthocyanins contained in the tuber as a source of bioactive compounds [1,2]. The type of anthocyanin found in purple sweet potato is cyanidin 3-cafeol-sophoroside-5-glucoside and peonidin 3-cafeol-sophoroside-5-glucoside [1,3,4,5]. Ayamurasaki variety contains 74% peonidin and 19% cyanidine from acylated anthocyanins [6]. Acylated anthocyanins in purple sweet potatoes are stable against changes in pH, heat, has antioxidant, and anti-mutagenic activity [1,7,8].

Purple sweet potato (PSP) is widely consumed in the form of fried/boiled or processed into cakes. PSP also began to be developed into flour to be used as food ingredients, for example for noodles. The powder is a dry preparation with specific mash made through the stages of counting, drying, grinding, and sieving. Purple sweet potato flour that is circulating in the market is generally brownish purple; this is because there is a browning process.

Sweet potatoes naturally contain phenol and phenolase enzymes [9, 10], so that after the stripping process is straightforward to enzymatic browning [11], which is accelerated with exposure to oxygen. The browning process can affect the colour of sweet potatoes, so enzymes need to be inactivated. Enzyme inactivation can be done by steaming, boiling, frying, or baking. Thus, in this study, the process of blanching was carried out to inactivate the sweet potato phenolase enzyme.
2. Method
The material used is the Ayamurasaki variety PSP obtained from farmers in Cilembu. Ayamurasaki PSP variety (with a planting period of 5 months). After harvesting PSP is washed, air dried and then stored for seven days in a ventilated room with 80% humidity. Purple sweet potato until this stage is called fresh PSP. Chemicals used for analysis include methanol, KCl, CH$_3$COONa, NaOH, and HCl from Merck Germany, each treatment made two replications with triple analysis.

The main equipment used for making PSP dried slice is peeler, slicer, steamer, boiler, and tray. Analytical tools used include centrifuges (Hermle Z383K), Buchi Switzerland R210 rotary evaporator, colorimeter (Minolta CR 310) and UV-Vis Spectrophotometer (2450 Shimadzu).

2.1. Purple Sweet Potatoes (PSP) dried slice preparation
PSP Dried Slice production through PSP washing, PSP stripping, slicing, steam or boil blanching, and drying. A total of 0.5 kg of the sample was washed in running water, drained, peeled with a stainless peeler, sliced, steamed or boiled for 2 minutes, dried with sunlight for 24 hours at three days. Thin pieces of PSP dry, stored at dry place and room temperature until analysed.

2.2. Anthocyanin extraction
Anthocyanin extraction of samples followed the method of Huang et al with modifications to the ratio of the number of samples to the solvent, and the type of water used [12]. One gram of sample was suspended in 32 mL of 15% methanol acid solution HCl (HCl, 1.5 M in methanol). The suspension is stirred in a rocking water bath at 50 °C for 60 minutes. Then the suspension of the sample was centrifuged at a speed of 4000 rpm for 15 minutes. The supernatant is separated and filtered with Whatman Filter paper No 1. The precipitate is extracted again with 15% methanol acid solution twice more; then the supernatant is collected in a dark bottle. A total of 88 mL of the supernatant was evaporated with an R210 Swiss Buchi rotary evaporator at 40 °C, 4 rpm for 20 minutes until concentrated anthocyanin extract was obtained which was characterized by the formation of precipitates. 5-7 mL of concentrated anthocyanin extract was stored in a dark bottle, stored in cold temperatures until used for analysis.

2.3. Colour measurement
The colour of the sample is measured with a colorimeter with the CIELAB measurement system [13]. The parameters measured include L * (Lightness), a * = red (+) to green (-), b * = yellow (+) to blue (-). Chromacity (C) shows the colour intensity calculated by the formula $\sqrt{(a ^* + b ^*) ^*}$. Hue angle (H *) is calculated as tan$^{-1}$(b */ a *). Hue is expressed as an angular degree starting from 0° – 360°, where 0° (red) is in the + a * quadrant, rotates counter clockwise 90° (yellow) for + b *, 180° (green) for -a *, 360° (blue) for -B *. The colorimeter is calibrated with L * = 92.75, a * = -0.76, b * = -0.07. The sample was put into a petri dish, levelled the surface, then measured with a Minolta CR 310 colorimeter. The colour parameter values were calculated from an average of three replications of measurements.

2.4. Monomeric anthocyanin analysis
Monomeric anthocyanin analysis refers to the method of [1] namely, the technique used by Lee et al [14]. This method is based on differences in anthocyanin structure at pH 1 and pH 4.5. As much as 1 mL of anthocyanin extract was put into a 5 mL volumetric flask, then added with KCl buffer solution (0.025 M) pH 1 to a volume of 5 mL. Then 1 mL of anthocyanin extract was put into another 5 mL volumetric flask, then added Na-acetate (0.4 M) buffer solution to pH 4.5 to a volume of 5 mL. Both pumpkins are placed in a dark room for 60 minutes. The absorbance of each solution after reaching equilibrium was measured by UV-Vis spectrophotometer at wavelengths which gave maximum absorbance and at a wavelength of 700 nm with blanks. Furthermore, monomeric anthocyanin (CyE) is calculated using two equations (1) and (2) [1]. Anthocyanin monomers were calculated and expressed as equivalent to cyanidin-3-glucoside (CyE, C21H21O11, mg / L).
\[ A = (A_{\lambda_{\text{vis-max}}} - A_{700})_{\text{pH1.0}} - (A_{\lambda_{\text{vis-max}}} - A_{700})_{\text{pH4.5}} \] .......................... (1)

Anthocyanin monomeric (CyE, mg/L): \[ \frac{A \times \text{BM} \times \text{FP} \times 1000}{\varepsilon \times l} \] .......................... (2)

where \( A_{\lambda_{\text{vis-max}}} \) (absorbance at the maximum absorption wavelength in the visible light region); \( A \) (absorbance), \( \text{BM} \) (molecular weight of cyanidin-3-glucoside, 449.2 g / mol), \( \text{FP} \) (dilution factor), \( \varepsilon \) (molar absorptivity of cyanidine - 3 - glucoside, 26900 L / cm / mol), \( l \) length of cuvette cell (1 cm) and 1000 conversion factors g to mg.

All measurements were carried out three times. To get the maximum absorbance, the spectrum of the sample solution is measured at a wavelength of 350-700 nm. This sample shows \( \lambda_{\text{vis-max}} \) at a wavelength of 521 nm for pH 1 and 544 nm for pH 4.5.

3. Results and discussion

3.1. Colour

The fresh PSP has a red-purple colour (Figure 1A). PSP colour changes after steam blanch process and dried with sunlight become bright purple (Figure 1B). Dried Slice PSP with boil blanch come a brownish and less purple (Figure 1C). The process of steam blanch can inactivate the anthocyanase enzyme, polyphenol oxidase, and peroxidase so as not to degrade anthocyanin [15,16]. The natural enzymes contained in the PSP inactive due to steam blanching proses (Figure 1B). In contrast to the colour of dried slice PSP with boil blanch come a brownish, and less purple (Figure 1C). Boiled blanch process can dilute the anthocyanin in water. So, the water comes purple, and the slice comes brownish and less purple.

![Figure 1](image1.png)

**Figure 1.** Purple Sweet Potato A: Fresh, B: Dried Slice with Steam Blanch Process, and C: Dried Slice with Boil Blanch.

The visual colour change in Figure 1 was confirmed by objective measurements with the colorimeter (Table 1). The colour parameters (\( L^* \), \( a^* \), \( b^* \), \( C \) and Hue) differ significantly (\( P <0.05 \)) in fresh PSP, Dried slice PSP with steam blanch process (SPSP), and Dried slice PSP with boil blanch (BPSP). From the \( L^* \) and \( b^* \) parameters, the SPSP shows the brightest purple-blue colour and based on the colour intensity parameter (C), and \( a^* \) SPSP shows the highest colour strength compared to the fresh PSP and BPSP. The FPSP and the SPSP shows a bluish-purple colour, with \( a^* \) positive, \( b^* \) negative. Based on the degree of Hue PSP tends to show a reddish-purple colour, while the BPSP show brownish purple.
Table 1. Colour characteristics of PSP, FSB, and FNS.

| Sample PSP       | L*       | a*      | b*      | C     | Hue (°)   |
|------------------|----------|---------|---------|-------|-----------|
| FPSP             | 30.05 ± 0.04<sup>b</sup> | 21.28 ± 0.09<sup>b</sup> | -1.27 ± 0.01<sup>c</sup> | 21.31 ± 0.09<sup>b</sup> | 356.63 ± 0.06<sup>a</sup> |
| SPSP             | 38.04 ± 0.05<sup>a</sup> | 28.88 ± 0.26<sup>a</sup> | -0.75 ± 0.29<sup>a</sup> | 28.88 ± 0.27<sup>a</sup> | 358.60 ± 0.56<sup>b</sup> |
| BPSP             | 24.24 ± 0.05<sup>c</sup> | 6.60 ± 0.02<sup>c</sup> | -1.36±0.01<sup>b</sup> | 6.74 ± 0.02<sup>c</sup> | 348.47 ± 0.06<sup>c</sup> |

FPSP: Fresh Purple Sweet Potato, SPSP Dried Slice PSP with Steam Blanch, BPSP: Dried Slice PSP with boil Blanch; L* (Lightness, brightness), a* (redness) b* (Yellowness), C (chromacity). Numbers followed by different letters in the same column show the results of the test are significantly different (P <0.05)

3.2. Monomeric anthocyanin concentration

The concentration in monomeric anthocyanin from FPSP, SPSP, and BPSP are presented in Table 2. The monomeric anthocyanin concentrations of fresh FPSP, SPSP, and BPSP were significantly different (P <0.05). The SPSP monomeric anthocyanin concentration is greater than that of FPSP and BPSP. Monomeric anthocyanin concentrations were respectively 2.84 ± 0.10 mg CyE / gram (db) for FPSP, 3.19 ± 0.12 mg CyE / gram (db) for SPSP, and 2.19 ± 0.06 mg CyE / gram (db) for BPSP. In this study, fresh PSP that has been peeled and cut is then stored in cold temperatures, frozen and freeze-dried. During the cooling process, it is estimated that peroxidase, polyphenol oxidase, and anthocyanase enzymes are still actively oxidizing anthocyanin so that the anthocyanin count is lower than the SPSP. Jang et al also showed that the polyphenol oxidase enzyme found in purple fleshy potatoes was very active at room temperature and degraded at temperatures higher than 70 °C [15].

Table 2. Fresh monomeric anthocyanin concentrations of PSP, FSB, and FNS.

| Sample                        | Concentration of anthocyanin mg CyE/g (db) |
|-------------------------------|------------------------------------------|
| Fresh Purple Sweet Potato (FPSP) | 2.84 ± 0.10<sup>b</sup>                  |
| Dried Slice with Steam PSP (SPSP) | 3.19 ± 0.12<sup>a</sup>                  |
| Dried Slice with Boil PSP (BPSP) | 2.19 ± 0.06<sup>c</sup>                  |

Numbers followed by different letters in the same column show the results of the test are significantly different (P <0.05), db: dry base.

The results of this study are in line with those reported by Truong et al cooking with steaming for 25 minutes in some purple sweet potato varieties can increase the concentration of monomeric anthocyanin, although it did not have a significant effect on changes in total anthocyanin concentration [16]. Likewise, Lachman et al reported that the monomeric anthocyanin concentration in purple potatoes increased 4.5 times after steaming [17]. But Kim et al reported different results, namely the Shinzami variety PSP anthocyanin concentration was reduced by almost half when vacuum cooked 121 °C for 10 minutes [18].

The lowest amount monomeric anthocyanin concentration in BPSP because the anthocyanin release in water, so water that used for boiled blanch come to be purple. The process of steaming or freezing pieces of fresh sweet potatoes before anthocyanin extraction can minimize anthocyanin damage and phenolics [16].

4. Conclusion

The relative steam blanch process is more able to maintain the colour and number of anthocyanins in dried slice PSP. Steam blanch can inactivate phenolase enzymes and other enzymes naturally found in purple sweet potatoes. Enzymes contained in sweet potatoes when there is oxygen can cause oxidation, which causes enzymatic browning reactions. Giving heat can denature enzyme proteins. So that the steam blanch process can strengthen the colour. Boil blanch not recommended for PSP, because the anthocyanin can dissolve in water.

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