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ASSESSMENT OF PURPLE SWEET POTATO FLOUR ANTIN 2 AND ANTIN 3 VARIETIES NUTRITIONAL QUALITY USING VARIOUS DRYING TEMPERATURE

Siti Farida[1,✉], Elfi Anis Saati[2], Damat Damat[3] and Ahmad Wahyudi [4]

[1] *University of Muhammadiyah Malang, Doctoral Program of Agriculture Science, Indonesia*
[2,3]*The University of Muhammadiyah Malang, Department of Food Science and Technology, Faculty of Agriculture and Animal Science, Indonesia*
[4] *University of Muhammadiyah Malang, Department of Animal Science, Faculty of Agriculture and Animal Science*
✉*farida.siti0705@mail.com*

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ABSTRACT

To produce purple sweet potato flour (*Ipomoea batatas* L.) through natural drying under sunlight is weather dependent and has fluctuating quality. Drying with a cabinet dryer has the potential to ensure consistency and time efficiency. This study aims to assess differences in purple sweet potato varieties and drying temperature on antioxidant activity, anthocyanin levels, and chemical characteristics of flour in Antin 2 and Antin 3 varieties. The study was designed using a randomized complete design with two factors, including factor I (Antin 2 and Antin 3 varieties) and factor II of drying cabinet drying temperature (40ºC, 50ºC, and 60ºC), while fresh tuber as a control. Parameters observed included antioxidant activity, anthocyanin content, water content, ash content, protein content, fat content, carbohydrate content, vitamin A, vitamin C, and purple sweet potato flour. Data were analyzed using the ANOVA test. The Antin 3 variety has higher levels of anthocyanins and antioxidants than the Antin2 variety. Antin 3 has a significantly higher fat and Vitamin A content than Antin 2 variety. Antin 2 has significantly higher protein and vitamin C content than Antin 3 variety. The temperature has a significant effect on water and carbohydrate content.

1.Introduction

Sweet potato [*Ipomoea batatas* L. (Lam.)] is one of the world's most important and versatile food crops (Alam et al., 2010; Escobar-Puentes et al., 2022). Indonesia is one of the five sweet potato-producing countries with total exports of more than 2.3 million tons (FAO 2013). Sweet potato contains a variety of nutrients and xenobiotic phytochemicals with antioxidant, anticoagulant, antibacterial, anti-nyctalopia/xerophthalmia, hepatoprotective/ spasmolytic, and antidiabetic potential (Escobar-Puentes et al., 2022). There are many types of purple sweet potato in Indonesia, both local and introduced. Antin 2 and 3 are new varieties resulting from the breeding of the Research Institute for Nuts and Tubers. Both varieties have a high level of productivity and anthocyanin content. The Antin 3 variety contains 7 times higher anthocyanin than the local purple sweet potato of Gunung Kawi (Kurniasari et al., 2021). The results of other studies also reported that the Antin 3 variety had anthocyanin content of 150.7 mg/100 g while Antin 2 was 130.2 mg/100g (Anonim, 2020).

Anthocyanins function as powerful natural antioxidants to reduce and neutralize free radical compounds in the body. The chemical components of purple sweet potato are influenced by the type, variety, maturity level, processed form, and environmental conditions such as temperature, pH, and light.

Anthocyanins are natural antioxidants that are highly reactive, easily oxidized, and reduced and their glycoside bonds are easily hydrolyzed, causing damage and decreased antioxidant activity due to contact with air, changes in temperature, pH, and processing. Anthocyanin color stability and anthocyanin antioxidant activity can be influenced by external and internal factors. External factors include pH, temperature, humidity, light, salinity, and storage conditions. Meanwhile, internal factors other than ascorbic acid and sugar are the presence of enzymes, proteins, metal ions, and other polyphenols as well as intramolecular complexation. Furthermore, it is known that the activity and stability of anthocyanins can be maintained at pH below 4.6, and in storage of food processing products anthocyanins are recommended to be maintained at pH 3 (Chen et al., 2019). This is confirmed by the results of another study which reported the antioxidant activity of two anthocyanin fractions and co-pigment (primary phenolic acid) of purple sweet potato cultivar Eshu No.8 which was simulated in vitro and found to be stable in gastric digestion under acidic conditions (Yang et al., 2019). conducted in China showed that there were differences in nutritional content, dietary fiber, total phenolic, antioxidant activity, and anthocyanin content in four sweet potato cultivars.

Purple sweet potato processed in different ways will affect the nutritional content and antioxidant activity of anthocyanins. Problems that often occur in the use of tubers in fresh conditions, among others, require a large storage space, are less practical and easy to rot. Processing tubers into flour has advantages over fresh form because it can be stored longer, is more practical and efficient. Processing in the form of flour can also increase its economic value and can provide raw materials for an industry so that it has the potential to become alternative flour as a raw material for cakes and biscuits. On the other hand, purple sweet potato processing can affect antioxidant activity and anthocyanin stability. Processing of purple sweet potato reduces the level of raw antioxidants as indicated by a very strong IC50 value of 5.0 mg/L which decreases to 47.82 mg/L after steaming and becomes 82.22 mg/L after boiling. The decrease in antioxidant levels was directly proportional to the decrease in total phenolic and anthocyanin levels of purple sweet potato extract. Besides being able to reduce antioxidant activity, sweet potato processing can also reduce nutritional content such as water content, ash content, fat content, protein content, fiber content, and total carbohydrates (D'Amelia et al., 2022; Putri, 2019). Processing of fresh purple sweet potato into powder form requires appropriate techniques and methods to maintain color, nutritional content, antioxidant activity, and anthocyanin levels.

The data generated from previous research on the manufacture of purple sweet potato flour only focused on certain components for drying techniques and methods, use of tools and analysis of chemical components, antioxidant activity, and anthocyanin levels. The drying method by drying in direct sunlight takes quite a long time (2 - 3 days). Due to the erratic weather, this drying method is less effective and produces fluctuating products, which can even fail. Therefore, it is necessary to research drying temperature treatments of 40ºC, 50ºC, and 60ºC using a cabinet dryer in the manufacture of purple sweet potato flour varieties Antin 2 and Antin 3 to maintain nutrient content, antioxidant activity, and anthocyanin levels to produce quality sweet potato flour suitable for industrial scale.

2. Materials and methods

The purple sweet potato varieties Antin 2 and Antin 3 were collected from Blitar and Malang Regency. The chemicals used in the analysis are distilled water, diethyl ether or petroleum ether, hexene, H_2SO_4, HCl, K_2SO_4, NaOH, 40% NaOH, 4% boric acid, 96% ethanol, DPPH solution (1,1-diphenyl-2-picrylhydrazyl), SDS (Sodium dodecyl sulfate, Brand), and other analytical chemicals.

2.1. Sweet Potato Flour Preparation

The production of purple sweet potato flour of Antin 2 and Antin 3 varieties was done by modifying the method from another study (Moloto et al., 2021), through the stages of sorting, cleaning, washing and peeling fresh sweet potatoes with good quality (purple sweet potato flesh and skin). The sweet potato tubers were peeled into thinly sliced using a saw blade to produce of aproximately 3 mm chips. The raw chips were dried using a cabinet dryer with a temperature treatment (40°C, 50°C, 60°C) for 2 x 48 hours (2 days) at a constant temperature. After drying process, the chips were floured using a chopper and filtered using an 80-mesh sieve to produce fine flour.

2.2. Antioxidant Activity Test

The antioxidant activity of sweet potato has been modified using 2-2 diphenyl 1-picrylhydrazyl (DPPH) as a free radical following previous studies(Yang et al., 2019; (Damat et al., 2020). The sample solution was made by mixing of 5 grams of sweet potato, 50 ml volumetric flask and water/ethanol to the mark. Then the 4 ml sample solution, 2 ml DPPH (0.001 g DPPH and methanol were mixed in a 50 ml volumetric flask) was put in a vial, shaken to homogenize, and incubated for 30 minutes in a dark room. The absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 515 nm. The formula used to calculate antioxidant activity is as follows

$$\text{Antioxidant activity (\%)} = \frac{(\text{Absorbent Blank} - \text{Absorbent Sample})}{(\text{Absorbent Blank})} x\ 100\% \quad \textbf{(1)}$$

where :

Absorbent Blank = Absorbance of DPPH before being reacted with the sample

Absorbent Sample = Absorbance of DPPH after being reacted with the sample

2.3. The total anthocyanin

The total anthocyanin content of purple sweet potato using UV-VIS spectrophotometric differential pH method adapted from [7, 13, 14]. 50 mg of purple sweet potato extract was acidified with 1% HCl until it reached pH 1.0 then diluted with 10 ml of 96% ethanol. Furthermore, 1 ml of the extract solution was put into 2 small tubes, each added with 5 ml of KCl buffer pH 1.0 and 5 ml of Na-Acetate buffer pH 4.5, shaken until dissolved for approximately 30 minutes. Absorbance measurements were repeated twice at wavelengths 505 and 700 nm. The total anthocyanin content was calculated using the following formula:

$$\text{Total anthocyanin content} = \frac{A \times MW \times DF \times V \times 100}{\varepsilon \times I \times W} \quad \textbf{(2)}$$

Where :

A	= Sample absorbance value
MW	= Molecular weight cyanidin-3-glucoside (449.2 g/mol)
DF	= Dilution factor
V	= Primary liquor volume
W	= Extract weight (g)
100	= Conversion factor calculation in mg/100g sample
ε	= Molar absorptivity Sianidin-3-glukosida = 26,900 L/(mol.cm)
I	= Cuvette Width at 1 cm

2.4. Color Test

Color determination was carried out using a color reader based on the method referred to a previous study (Ruttarattanamongkol et al., 2016). This analysis uses the L*, a*, and b* hunter system, where colors are divided into 3 color dimensions; namely the symbol L (Lightness) is the level of brightness, and the symbol a* for the dimensions of redness and greenness, the symbol b* for the dimensions and bluish.

2.5. Proximate Analysis

Testing the nutritional content of purple sweet potato using proximate analysis that has been done following the other study (Ramdath et al., 2020). It consists of water content (gravimetric), ash content (AOAC 923.03), dietary fiber (AOAC 991.43), protein content (AOAC 992.15), fat content (AOAC 922.06), carbohydrate content based on differences (CHO) % = [100% moisture% – protein% – fat% – ash%]). Vitamin A was measured by Spectrophotometric Method (AOAC), whilte Vitamin C was measured by Iodine Titration Method (Ramdath et al., 2020).

2.6. Data Analysis

The study adopted a randomized complete design with two factors, including factor I (Antin 2 and Antin 3 varieties) and factor II of drying cabinet drying temperature (40ºC, 50ºC, and 60ºC), while fresh tuber as a control/comparison. Parameters observed included antioxidant activity, anthocyanin content, water content, ash content, protein content, fat content, carbohydrate content, vitamin A, vitamin C, and purple sweet potato flour. Each treatment was repeated 4 times (except for anthocyanin content) so that there were 32 experimental trials. The anthocyanin content was repeated two times. Data on measure variables were analyzed using the two-way ANOVA eccept data of Vitamin A. Data of Vitamin A did not meet the requirements of the normality test. So the data of Vitamin A was analyzed non-parametrically using the Kruskal-Wallis test.

3.Results and discussions

3.1. Total Anthocyanin Content

The total anthocyanin contents of the fresh tuber of Antin 2 variety was 1349.46 mg/kg, while that in Antin 3 variety was 2407.16 mg/kg.

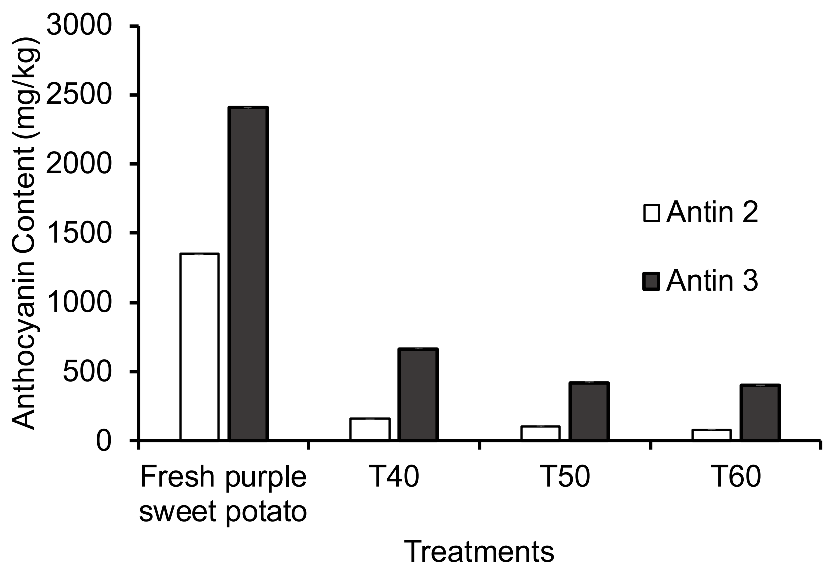

Figure 1. The average total anthocyanin content of purple sweet potato varieties Antin 2 and Antin 3 treated with drying temperatures of 40ºC (T40), 50ºC (T50) and 60ºC (T60) (N = 2)

After the purple sweet potato was processed into flours with the difference in drying temperatures, the total anthocyanin content of the purple sweet potato flours in the Antin 2 variety ranged from 82.02 mg/kg to 159 mg/kg, while those in Antin 3 variety ranged from 399.5 mg/kg to 661.97 mg/kg. overall, the total anthocyanin contents in Antin 3 variety were higher than those in Antin 2 variety. Anthocyanin levels in both varieties decreased with increasing temperature (Figure 1).

The difference in the anthocyanin content of the two varieties can be physically observed in the different colors of the tuber flesh. The red and purple colors are determined by the type of anthocyanin, and the red color is mostly determined by cyanidin and peonidin. The purple sweet potato of the Antin 3 variety has blackish purple flesh, while the purple sweet potato of the Antin 2 variety is reddish purple.

This study indicates that the Antin 3 variety has higher levels of anthocyanins and antioxidants than the Antin2 variety. The heating process during drying was able to reduce the anthocyanin content of purple sweet potato which was indicated by the change in the color of the flour produced. The stability, quality, and color of anthocyanins are determined by changes in temperature, pH, and the ratio of solid-liquid concentrations, where the pH change factor is more dominant than temperature changes. (Rodriguez-Amaya, 2018; Tang et al., 2019). Furthermore, it is shown by the other study that longer exposure to heat will result in lower anthocyanin levels. Anthocyanins are heat-sensitive pigments that cause changes in the anthocyanin structure, namely the opening of the aglycone ring of the flavylium cation and the formation of colorless carbinol and chalcone compounds. The decrease in color intensity affects the color absorption performance in the total antioxidant test (Ticoalu & Maligan, 2016).

The blue to purple color is influenced by delphinidin, petunidin, and malvidin, while pelargodin is responsible for the orange color (D'Amelia et al., 2022). Each type of purple sweet potato in addition to having a different color also has different chemical characteristics and antioxidant activity depending on the type of anthocyanin and phenolic compounds contained in it (Ji et al., 2015).

The heating process during drying was able to reduce the anthocyanin content of purple sweet potato which was indicated by the change in the color of the flour produced. Furthermore, longer exposure to heat lead to lower anthocyanin levels. Anthocyanins are heat-sensitive pigments that cause changes in the anthocyanin structure, namely the opening of the aglycone ring of the flavylium cation and the formation of colorless carbinol and chalcone compounds. The decrease in color intensity affects the color absorption performance in the total antioxidant test (Ticoalu & Maligan, 2016). The heating process during drying was able to reduce the anthocyanin content of purple sweet potato which was indicated by the change in the color of the flour produced.

3.2. Average of Antioxidant Activity, Protein, Fat, Carbohydrate and Vitamin C content

The average antioxidant activity of fresh tuber of Antin 3 variety was 82.07% ± 0.12, while that in Antin 2 variety was 49.83% ± 2.85. After the purple sweet potato was processed into flours with the difference in drying temperatures, the total anthocyanin content of purple sweet potato flours in the Antin 3 variety ranged from 59.81% – 77.68%, while those in Antin 2 variety ranged from 23.19% – 38.80% (Table 1). The water content of fresh tubers of Antin 2 variety was 60.52±0.29, while that in Antin 3 was 59.68±0.23. The highest water content was found in the 40^{o}C treatment, while the lowest was in 60^{o}C. The water content decreases with increasing temperature (Table 1). The average ash content of potato flours in the Antin 3 variety ranged from 0.97% – 1.06%, while those in Antin 2 variety ranged from 0.97% – 0.98% (Table 1).

The protein content of purple sweet potato flour in the Antin 2 variety was higher than the Antin 3 variety. The average protein content of fresh tuber of Antin 2 variety was 6.99% ± 0.63, while that in Antin 3 variety was 4.57% ± 0.56. After flour processed, protein content of purple sweet potato flours in the Antin 2, it ranged from 5.33% to 6.30%, while the Antin 3 variety produced an average protein content of 2.21% - 2.71%. The highest protein content was found in fresh Antin 2, while the lowest was found in fresh Antin 2 treatment in 60^{o}C (Table 1). The high and low levels of protein in food have influenced the variety of purple sweet potatoes, temperature, maturity and processing time. Protein is a source of amino acids that contain elements C, H, O, and N.

The average fat content of the Antin 3 variety was higher than that of the Antin 2 variety. The fat content of the Antin 3 variety ranged from

1.27% to 2.58%, while the Antin 2 variety ranged from 1.08% - 1.41%. The lowest fat content was found in the Antin 2 treatment in 60°C, while the highest was found in fresh Antin (Table 1). The average carbohydrate content of the Antin 3 variety was higher than that of the Antin 2 variety. The carbohydrate content of the Antin 3 variety ranged from 31.47% to 85.74%, while the Antin 2 variety ranged from 30.91% to 83.72%. The highest carbohydrate content was found at Antin 3 treatment in temperature of 60°C, while the lowest was found in fresh Antin 2. The average vitamin A content of the Antin 3 variety was higher than that of the Antin 2 variety. The Vitamnin A content of the Antin 3 variety ranged from 42.05 to 51 mg/100g, while those in the Antin 2 variety ranged from 3.76 to 21.13 mg/100g (Table 1). The average vitamin C content of the Antin 3 variety was higher than that of the Antin 2 variety. The vitamin C content of the Antin 2 variety ranged from 1.06 to 1.52 mg/100g, while the Antin 3 variety ranged from 0.76 to 1.23 mg/100g (Table 1).

Table 1. Average of antioxidant, water, ash, protein, fat, carbohydrate and Vitamin C content in purple sweet potato of Antin 2 and Antin 3 varieties before and after drying treatment

Treatment	Antioxydant (%)	Water (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Vitamin A (mg/100g)	Vitamin C (mg/100g)
Antin 2 fresh	49.83±2.85	60.75±0.30	0.92±0.03	6.99±0.63	1.32±0.14	30.91±0.73	21.13±2.04	1.52±0.12
Antin 2 T40	38.80±0.67	11.98±0.11	0.98±0.00	6.30±0.96	1.41±0.09	80.88±0.91	10.55±1.72	1.24±0.27
Antin 2 T50	37.05±0.98	11.79±0.13	0.97±0.00	5.41±0.54	1.15±0.04	81.55±1.23	3.76±0.00	1.17±0.29
Antin 2 T60	23.19±0.32	9.54±0.25	0.98±0.00	5.33±0.57	1.08±0.01	83.72±1.11	3.90±0.40	1.06±0.37
Antin 3 fresh	82.07±0.12	59.99±0.36	0.96±0.02	4.57±0.56	2.58±0.29	31.47±0.80	51.00±2.81	0. 94±0.12
Antin 3 T40	73.60±1.15	11.16±0.13	0.97±0.00	2.51±0.37	2.31±0.07	82.42±0.89	48.81±3.77	0.82±0.15
Antin 3 T50	77.68±4.77	9.13±0.05	1.06±0.03	2.71±0.37	2.22±0.07	83.66±1.28	43.40±1.01	0.76±0.12
Antin 3 T60	59.81±0.64	8.71±0.12	0.97±0.00	2.21±0.24	1.27±0.45	85.74±1.06	42.05±8.81	0.76±0.12

The effect of sweet potato variety was significant on Antioxydant (3), Protein (2), Fat (3) and Vitamin C content (2), while the effect of temperature was significant on Water, Ash, Carbohydrate (Table 2). The effect of sweet potato variety was significant (χ = 17.280, P < 0.001) on Vitamin A content (3), while that of drying temperature was not significant (χ = 2.727, P > 0.05).

Table 2. Statistical F value and significance from the results of parametric analysis on the chemical composite of purple sweet potato average variable

Treatment	Antioxydant	Water	Ash	Protein	Fat	Carbohydrate	Vitamin C
Effect of variety							
F-value	105.654	0.026	3.176	41.577	19.726	0.036	9.101
Sig.	0.000	0.874	0.085	0.000	0.000	0.851	0.006
Effect of drying temperature							
F-value	2.117	6,328	5.178	1.684	2.082	1,232	0.701
Sig.	0.121	0.000	0.006	0.193	0.126	0.000	0.562

Anthocyanin level has a significant positive correlation with water and vitamin C content. It has a significant negative correlation with carbohydrates. Antioxidant levels were significantly positively correlated with fat and vitamin A levels. Water content was significantly positively correlated with vitamin C. Water content was significantly negatively correlated with carbohydrates. Protein content has a significant negative correlation with Vitamin A. Fat content has a significant positive correlation with Vitamin A. Carbohydrate content has a significant negative correlation with Vitamin C (Table 3).

Table 3. Correlation between variables

	Ac	Ao	Wa	Ash	Pro	Fat	Car	VA	VC
Ac	1.000	0.606	0.898	-0.422	0.095	0.619	-0.897	0.559	0.865
Ao			0.290	0.263	-0.623	0.901	-0.289	0.959	0.391
Wa				-0.619	0.461	0.286	-1.000	0.218	0.939
Ash					-0.557	0.279	0.609	0.202	-0.536
Pro						-0.466	-0.468	-0.728	0.448
Fat							-0.291	0.829	0.441
Car								-0.213	-0.942
VA									0.267

Note Ac = Antocyanin, Ao = Antioxydant Wa = Water Pro = Protein Car = Carbohydrate VA = Vitamin A, VC = Vitamin C. cell with grey color means that correlation between variable is significant (P < 0.05).

The high antioxidant activity of purple sweet potato in the Antin 3 variety is due to the high content of anthocyanins and beta carotene (precursor of vitamin A) which is indicated by a darker purple color compared to the Antin 2 variety which has a reddish-purple color. The difference in color between the two varieties of purple sweet potato is caused by the addition or subtraction of hydroxyl groups, the position of hydroxyl groups, methylation of hydroxyl groups, sugars bound to molecules, number and location of sugars bound to molecules, and aliphatic acids or aromatic acids attached to the molecule. Sugar. The color produced in plants will be stronger with the increasing number and length of conjugated double bonds in the anthocyanin structure (Alappat & Alappat, 2020; Amoanimaa-Dede et al., 2019; Hellmann et al., 2021). Antioxidants are compounds capable of eliminating, purifying, counteracting, or combining the effects of reactive oxygen. The main function of antioxidants is to try to minimize the oxidation of fats and oils, minimize the occurrence of spoilage processes in food products, prolong the shelf life in the food industry, increase the stability of fats contained in food, and prevent the degradation sensory and nutritional qualities (Minah et al., 2015).

The treatment of different drying temperatures for the manufacture of purple sweet potato flour on the Antin 2 and Antin 3 varieties decreased the antioxidant activity. Generally, the higher the drying temperature, the lower the antioxidant activity. A drying temperature of 60OC was able to reduce the antioxidant activity of fresh purple sweet potato Antin 3 varieties by 82.07% to 59.35%, while fresh Antin 2 varieties with antioxidant activity 50.07% to 23.28%. This shows that one of the factors that affect antioxidant activity can be heating when dried. Several factors that affect antioxidant activity include changes in pH, the presence of oxygen, processing, and light (Jiang et al., 2019; Safari et al., 2019). The processing of purple sweet potato reduces antioxidant levels, where the decrease in antioxidant levels is directly proportional to the decrease in total phenolic and anthocyanin levels from purple sweet potato extract (Salim et al., 2017).

Antin 3 has a significantly higher fat and Vitamin A content than Antin 2 variety. Antin 2 has significantly higher protein and vitamin C content than Antin 3 variety. Vitamin C is a water-soluble compound that is unstable and easily damaged by heating. The heating process can result in oxidation processes and non-enzymatic browning reactions that can reduce the vitamin C content in food. which are rich in vitamin C as in fruits. This is following the results of research by (Ameliya & Handito, 2018) that the higher the temperature and the duration of heating (boiling) the degradation of vitamin C in cherry syrup is also greater. Oxidation of vitamin C (ascorbic acid) will convert ascorbic acid into L-dehydroascorbic acid which is chemically very labile and can undergo further changes to L-ketogulonic acid which has no vitamin C activity (Ioannou, 2013).

The increase in the brighter color of purple sweet potato flour was due to the inhibition of polyphenol oxidase (PPO) activity (Ruttarattanamongkol et al., 2016). Generally, the processing of flour causes a loss of anthocyanins. Frying causes a total loss of anthocyanins about 46% of Blue Star varieties. Although there is a difference with cooking using a microwave which causes an increase in the total content of raw materials (D'Amelia et al., 2022)

The temperature has a significant effect on water and carbohydrate content. Water content decreases, while carbohydrate content increases with increasing temperature. The higher the temperature of the dryer, the more water that comes out of the material causing the lower the moisture content. Low water content can extend the shelf life to prevent damage caused by microorganisms or chemical damage. This shows that the water activity in the material is an important factor in the shelf life of dry food (D'Amelia et al., 2022; Ruttarattanamongkol et al., 2016).

Several factors that determine the high and low ash content of a material, among others, are caused by the different mineral content in the source of the raw material, the type of material, the method of ashing, the time, and the temperature used during drying. Ash content is inorganic substances or minerals contained in a material, the determination of ash content and composition depends on the type of material and the method of ashing. Determination of total ash content is useful as a parameter of the value of a food product because, with increasing ash content, the minerals contained in food products also increase(Setyowati & Nisa, 2014).

The protein content of food varies both in amount and type. Proteins from different sources have certain functional properties that affect the characteristics of the food. Proteins from different sources have certain functional properties that affect the characteristics of the food. The presence of the element N in determining the amount of protein can be determined by determining the amount of nitrogen (N) present in food. Nitrogen is the main element of protein because it is present in all proteins, which account for 16% of the total protein (Sundari et al., 2015). Protein in fresh food (before processing) has a higher protein content than after processing. The processing process with high-temperature heating and for a long time can damage the protein structure so that the protein content of the processed food decreases (Rijal et al., 2019). Proteins from different sources have certain functional properties that affect the characteristics of the food. The presence of the element N in determining the amount of protein can be determined by determining the amount of nitrogen (N) present in food. Nitrogen is the main element of protein because it is present in all proteins, which account for 16% of the total protein (Sundari et al., 2015). Protein in fresh food (before processing) has a higher protein content than after processing. The processing process with high-temperature heating and for a long time can damage the protein structure so that the protein content of the processed food decreases (Rijal et al., 2019).

Differences in protein content results can be caused during the processing/preservation of protein foods that are not controlled properly and can reduce protein levels. A processing process mainly using heat, such as sterilization, boiling, and drying can affect the protein content of foodstuffs. Excessive heat or other types of processing can damage the protein from a nutritional point of view, and it is also affected by the presence of other nutritional compounds contained in the ingredient. Processing causes changes in protein structure due to temperature increases, although not all of these changes are undesirable (Ariani et al., 2017). In addition to the type/variety of sweet potato, the protein content of sweet potato flour is also influenced by the peeling process during production. The excessive peeling process can cause the protein-rich part of the sweet potato meat to be wasted (Ariani et al., 2017).

Fat is an organic material that is soluble in organic solvents and is non-polar. The fat content of foodstuffs can affect the shelf life, the higher the fat content the lower the shelf life. This is evident in the storage of research raw materials, for the Antin 2 variety has a longer shelf life than the Antin 3 variety. Low-fat content can extend the shelf life of foodstuffs in the dry form (Damat et al., 2020). The results of the study using a cabinet dryer produced a higher fat content compared to the results of the other study on the purple sweet potato flour of the Ayamurasaki variety which was dried using an oven with a temperature of 40ºC which produced a fat content of 0.40% (Kassegn, 2018).

The carbohydrates contained in purple sweet potato flour are mostly in the form of starch, dietary fiber, and several types of sugar. soluble substances such as maltose, sucrose, fructose, and glucose (Ranonto & Razak, 2015). β-carotene tends to be damaged with higher heating. The decrease in beta-carotene content will be greater with increasing temperature and heating time as a result of damage to β -carotene by high temperatures. During drying, changes occur due to the isomerization reaction of cis-trans oxidation with the formation of epoxy carotenoids and apocarotenes (Ioannou, 2013). This causes a decrease in the content of beta-carotene in the material with increasing temperature. Factors that reduce and destroy β -carotene are oxygen, light, and heat. -carotene is easily oxidized in the air, this is due to the presence of a double bond structure in the β -carotene molecule. Oxidation will take place more rapidly in the presence of light, high-temperature heating, and metal catalysts. Decreased levels of -carotene can also occur with a longer heating process. Another factor that causes a decrease in beta-carotene levels in the production of flour from sweet potatoes is the milling process. During the milling process, there is contact with oxygen and there is constant friction between the sweet potato flour particles and the grinder wall, which generates a lot of heat (Kassegn, 2018).

3.3. Color Observation

Color analysis is carried out using a color reader with three value dimensions, namely, the first dimension is the L value which indicates the brightness level with a scale of 0-100, a value of 0 indicates a tendency for black or dark colors, while 100 indicates a tendency for white or light colors. The second parameter dimension a (+) value indicates the achromatic color of the red mixture with a scale of 0 – 80, and the value 0 – (-80) indicates a green color tendency. The third parameter, the b (+) value, shows a mixed achromatic color of yellow with a +b value of 0-(+70) and blue with a –b value of 0- (-70).

Table 3. Average Value of L, a+ and b+ Purple Sweet Potato Flour Antin 2 and Antin 3 varieties with different drying temperatures

Treatment	**Color**		
	L	**a (+)**	**b (+)**
Antin 2 T40	60,00	10,95	5,75
Antin 2 T50	61,30	9,65	8,35
Antin 2 T60	62,80	8,40	9,70
Antin 3 T40	54,45	11,00	1,70
Antin 3 T50	54,10	10,85	3,15
Antin 3 T60	55,25	10,20	3,75

Based on the table data, it is known that the Antin 2 purple sweet potato flour has a higher brightness level (L) value than the Antin 3 variety. An increase in the drying temperature of the purple sweet potato flour in both varieties shows a brighter color. Purple sweet potato flour in the dimensions of the a (+) value for the greenish-red color intensity is known to be the higher the drying temperature, the smaller the a

(+) value produced with a range of values ranging from 8.40 - 11.00. A decrease in the value of a* indicates color damage during processing using heat caused by a significant decrease in anthocyanin content.

The results of the study indicate that the intensity of the yellowish color (b + value) was inversely proportional to the reddish color intensity (a+) value, and an increase in the drying temperature increased the intensity of the yellowish color (b+) value. This shows that the heating process will produce flour with a color that leads to a yellowish and brighter larger L value. flour that acquires a greater heat intensity during the drying process. The increase in dark yellow color during the drying process is thought to be caused by a non-enzymatic reaction (Maillard reaction) that occurs between reducing sugars and free amine groups of amino acids and/or proteins.

4. Conclusions

This study indicates that the Antin 3 variety has significantly higher levels of anthocyanins, antioxidants, fat, and Vitamin A than the Antin2 variety. Antin 2 has significantly higher levels of protein and Vitamin C content than Antin 3 variety. The temperature has a significant effect on water and carbohydrate content. Water content decreases, on the contrary, carbohydrate content increases with increasing temperature.

5.References

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