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THE EFFECT OF CONCENTRATION RATIO OF PURPLE SWEET POTATO (*Ipomoea batatas* L) AND CASSAVA ON THE NUTRITIONAL CONTENT OF TORTILLAS

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ABSTRACT

Purple sweet potato is a source of anthocyanins that function as antioxidants, so that it has the potential to be processed into various functional food products. The stability of anthocyanin levels in the product is greatly influenced by temperature during processing, where the use of high temperatures will damage and reduce anthocyanin levels. This research was conducted to determine the effect of concentration ratio of raw materials on nutrition content of tortilla products made from a combination of purple sweet potato (Ipomoea batatas L) and cassava. The research design used a completely randomized design, with the object of research being tortillas made from purple sweet potato obtained from Palolo District, Sigi Regency, Central Sulawesi Province, combined with cassava obtained from the local market in Palu City, Central Sulawesi Province. The results showed that the anthocyanin levels of tortilla products varied from 5% to 19.63%. There was a very significant decrease in anthocyanin levels around 68.26 - 91.91%. The amount of antioxidant activity was measured by IC50, wherefrom the research it was known that the IC50 value of tortilla products ranged from 242.68 to 155.66 µg / ml which indicated that the antioxidant activity of tortilla products was weak and even almost inactive. This research also produced tortillas with water content ranging from 2.43 - 5.58%, fiber content ranging from 3,768 - 9,696% and total sugar ranging from 0.652 - 1,077%. Based on the results of the study, it is indicated that the processing of purple sweet potatoes into tortillas is not appropriate because the processing is predominantly using high temperatures so that it can damage the anthocyanin content and reduce antioxidant activity.

Keywords*:* Tortilla, Anthocyanin, Antioxidants, Purple Sweet Potato.

INTRODUCTION

Food diversification is one of the main pillars in realizing food security towards food independence and sovereignty (Nugrayasa, 2013). Therefore, the Ministry of Agriculture places food diversification as the second successful program after food self-sufficiency and sustainable self-sufficiency. The main objective of food diversification is to reduce the high level of dependence on rice and flour, which consumption has reached 139 kg/capita/year and 17 kg/capita/year, by increasing consumption and production of local food ingredients (Astono, 2013). One of the local food commodities in Central Sulawesi is purple sweet potato and cassava, it turns out that until now it is still less attractive and used as functional food even though its antioxidant content is very high (Rachman, 2008).

Purple sweet potato (Ipomoea batatas L. Poir) is a local food group that is a source of carbohydrates and contains antioxidants (Armanzah R.S and Hendrawati T.Y, 2016) and high food fiber (Nisviaty, 2006). The advantage of purple sweet potato is that the natural anthocyanin pigment content in it is around 80-98% acylated (Li et al., 2013). The amount of anthocyanin content varies from plant to plant and ranges from 20mg / 100gr to 600 mg / 100gr wet weight. Anthocyanins contained in purple sweet potato are very interesting to be processed into functional foods (Husna et al., 2013), as natural dyes (Samber et al., 2012), for food (Wegener et al., 2009) and beverages (Chisté et al., 2013). al., 2010) and has a role as an antioxidant (Teow et al (2007), Bondre et al (2012), Takahata et al (2011), Jiao et al (2012)). Besides, anthocyanin pigments from purple sweet potato can prevent diseases such as obesity and liver damage (Choi et al., 2010), anti-inflammatory (Grace et al., 2014), anti-diabetes (Sancho & Pastore, 2012), antimutagenic (Yamakawa & Yoshimoto, 2001), antihypertensive (Oki et al., 2016), anti-carcinogenic and can ward off free radicals (Jusuf et al., 2008), prevent the risk of colon cancer (Lim, 2012), and tumorigenesis (Terahara et al., 2004).

Commodities such as cassava (Manihot esculenta arantz) and purple sweet potato (Ipomoea batatas) are widely cultivated by farmers because they are easy to adapt to the environment. The content of these two commodities is the carbohydrate and is a source of starch. The carbohydrate content of cassava is 34.7% and in purple sweet potato is 31.59% (Astawan and Widowati, 2005). Cassava is one type of tuber that has potential as a functional food ingredient, by modifying the starch. Starch is a type of filler. These fillers can stabilize, concentrate, or thicken food mixed with water to form a certain thickness. The fillers used of this type are generally cornstarch (corn starch), tapioca (cassava starch), sago starch, and rice flour (Karleen, 2010). Tubers (including purple sweet potato and cassava) high in carbohydrates can be used in the manufacture of processed food products made from flour (Widatmoko & Estiasih, 2015).

In Central Sulawesi, the development of processed food products that combine purple sweet potato and cassava is still lacking, even though considering the high nutritional content, this commodity has the potential to be developed, one of which is chips or tortilla products which are very popular with most people. The tortilla was originally a typical food that was very popular in Mexico as a product of processed corn, the use of ingredients other than corn will increase nutritional value and at the same time increase the diversification of processed products. Tortilla chips are a snack made from crunchy and savory corn. Tortillas have an imbalance in nutritional value, which are high in carbohydrates and low in protein, due to their use of corn as the main ingredient (Dinnaryanti et al., 2019). Tortillas can be made from various types of ingredients that contain starch (Vitasari and Mappiratu, 2016). Some of the raw materials containing starch that have been processed into tortillas are tofu dregs (Setiawan, 2011), purple sweet potato (Winarti & Lestari, 2018), sweet potato and cassava added with wheat flour (Basrin et al., 2016), peanut flour soybean (Vania, 2020).

The combination of purple sweet potato and cassava in making tortillas and the processing that uses high temperatures affects the anthocyanin levels because its stability is greatly influenced by temperature. For this reason, this study aims to determine the effect of the concentration ratio of purple sweet potato and cassava as raw material, on nutritional content of tortillas.

RESEARCH METHODS

Materials

The raw material for purple sweet potato used in this research was obtained from Palolo District, Sigi Regency, Central Sulawesi Province. Other materials included cassava are obtained from the local market in Palu City, Central Sulawesi Province.

Standardized chemicals used when testing the observation parameters (anthocyanins content, antioxidants activity, moisture content, crude fiber content and total sugar content) were obtained from the Mathematics and Natural Sciences Laboratory, Tadulako University.

Methods

This research is based on research conducted by Basrin et al (2016), which used a completely randomized design with one main factor, namely the concentration ratio of purple sweet potato and cassava (1:5, 2:4, 3:3, 4:2, 5:1, 6:0).

The processing of tortilla products made from purple sweet potato combined with cassava is following the method used by Basrin et al (2016), which are : purple sweet potato, cassava (weight according to treatment) and 500 g rice flour, steamed separately until cooked then milled. Next, each of the ingredients mixed and seasoned, then milled again until homogeneous, then the dough is flattened using a pipe or glass bottle. Furthermore, the flat dough is sliced with a size of 1x1.5 cm, then dried in the sun for 2-3 days.

For further testing, total anthocyanin levels, antioxidant activity, moisture content, fiber content and polyphenol content were carried out.

Total Anthocyanin Levels

Anthocyanin extract for analysis was obtained by maceration for 24 hours using ethanol with a ratio of ingredients and solvents (1:10), then centrifuged at a speed of 5000 rpm for 14 minutes, then the supernatant was filtered using a vacuum filter, and the filtrate was concentrated with a rotary evaporator (35 ºC) until a concentrated extract is obtained (1/10 of the initial filtrate) (Husna et al, 2013).

Determination of total anthocyanin content was carried out based on the pH difference method (Giusti and Wrolstad, 2000). The anthocyanin extract was dissolved in KCl-HCl *buffer* (1 M, pH 1) and NaOAc buffer (1 M, pH 4.5) with a ratio of extract to *buffer* = 1: 5 (v / v). The absorbance of each solution was measured at a wavelength of 520 nm and 700 nm after being incubated for 15 minutes at room temperature, the results were included in the formula:

$$\mathbf{A = [(A_{510} - A_{700})_{pH\ 1} - (A_{510} - A_{700})_{pH\ 4,5}]}$$

After knowing the results of the above calculations, then entered in the Lambert-Beer law: A = ε.L.C. ε and molecular weight follow the dominant anthocyanin in purple sweet potato.

DPPH Method Antioxidant Activity (Andayani et al, 2012)

The anthocyanin extract from the purple sweet potato tortilla was taken as much as 25 mg in a 25 ml volumetric flask, then the volume was adjusted to 1 mg/ml with the addition of ethanol. After that, it is diluted again by adding ethanol to the concentration of 10, 30, 50, 70, and 90 ppm.

To test the antioxidant activity of each concentration, the sample solution was measured and pipette 0.2 ml and poured into the vial, then add 50 µM DPPH solution. Homogenize the mixture and leave it in a dark place, the absorption was measured by a UV-Vis spectrophotometer at a wavelength of 517 nm. Next, treat ascorbic acid (concentrations 2, 3, 4, 5, 6 ppm) like the treatment in the test sample, as a comparison.

The antioxidant activity of the sample is determined by the amount of DPPH radical absorption inhibition by calculating the percentage of DPPH absorption inhibition using the formula:

$$\% \text{ Inhibisi} = \frac{\text{Abs. DPPH 50 µM} - \text{Abs. Sampel}}{\text{Abs. DPPH 50 µM}} \times 100\%$$

The linear regression equation is used to calculate the IC_{50} value, which is the number that shows the concentration of the extract that can inhibit the activity of a radical by 50%. To determine IC_{50}, a standard curve equation of% inhibition as the y-axis and concentration of antioxidant fraction as the x-axis is required. IC_{50} is calculated by entering the value of 50% into the standard curve equation as the y axis then calculating the x value as the IC_{50} concentration.

Moisture Content

The crucible was placed inside drying oven for 105°C for 2 h. After that, the crucible was placed in the desiccators for allowing cooling. The beaker was weighed and 2 g of the powder was placed in the beaker. The sample was drying in drying oven (Memmert 600, Germany) for 3 h at temperature 105°C. Then the dried sample was weighed for percent of dry weight and percent of moisture content in sample.

Crude Fiber Content (AOAC, 1995)

The samples were oven dried at 60ºC for 21 hours. The dry sample of 2 g was extracted the fat with petroleum ether solvent at room temperature for 15 minutes then the sample was put in an oven for 12 hours at 105°C. The sample of 1 g was put into a 500 ml erlenmeyer and added 100 ml of H_2SO_4 0.325 N. The mixture was hydrolyzed in an autoclave for 15 minutes at 105°C, then 50 ml of NaOH 1.25N was added and hydrolyzed in an autoclave for 15 minutes at 105°C. Then, the solution is filtered with a glass plate G3 that known its weight. Then, the glass plate was washed consecutively with hot water, 25 ml H_2SO_4 0.325 N, hot water, and 25 ml ethanol 78%. The plate was dried in an oven at 105°C for 1 hour and put in a desiccator and weighed. Crude fiber content is determined by the formula:

$$\textbf{Crude fiber content} = \frac{A - B}{C} \times 100\%$$

Note: A = Weight of glass plate and dry residue (g), B = Weight of empty glass plate (g), and C = Weight of sample (g).

Total Sugar Phenol Sulfate Method (AOAC, 1995)

The standard glucose solution with sugar concentrations of 10, 20, 30, 40, 50 and 60 µg / ml was taken of 2 ml. Each was then put into a test tube and added 1 ml of 5% phenol solution, and added 5 ml of concentrated H_2SO_4 solution quickly. After being left for 10 minutes, the solution was then measured for its absorbance at λ = 490 nm. Determination of the total sugar concentration in the sample is carried out as in the standard curve, then the total sample sugar is determined as glucose.

Data Analysis

The data obtained were subjected to statistical Analysis of Variance (ANOVA) (Steel & Torrie., 1991), and the significant difference among the means were compared with the Duncan test with a probability $p \leq 0.05$.

RESULTS AND DISCUSSION

Results

Anthocyanin Levels

The results of the analysis of variance showed that the ratio of the concentration of purple sweet potato and cassava was very significant (Fhit = 27.02> Ftab (α = 0.1) = 4.25) on the anthocyanin content of tortilla products.

Based on Figure 1, it can be seen that the lowest mean value of total anthocyanin content of 5% is found in tortilla products with the ratio of concentrations of purple sweet potato and cassava, namely 1 part purple sweet potato: 5 parts cassava, while the average value of the highest total anthocyanin content 19.63% was found in tortilla products with a concentration ratio of purple sweet potato and cassava, namely 5 parts purple sweet potato: 1 part cassava.

From these data, it is also seen that the 5 parts of purple sweet potato: 1 part of cassava has anthocyanin levels greater (19.63%) than 6 parts of purple sweet potato: 0 parts of cassava which is 13.44%. This shows that the addition of cassava as a raw material affects the anthocyanin levels of the tortilla.

Antioxidant Activity

The results of the analysis of variance showed that the ratio of the concentration of purple sweet potato and cassava was very significant (Fhit = 20.415> Ftab (α = 0.1) = 4.24) on the antioxidant activity of tortilla products.

Based on Figure 2, it can be seen that the weakest mean value of anthocyanin activity (the highest average value) of 242.675 μg/ml is found in tortilla products with the concentration ratio of purple sweet potato and cassava, namely 1 part purple sweet potato: 5 parts cassava, whereas The strongest mean value of anthocyanin activity (the lowest average value) of 155.661 μg / ml was found in tortilla products with a concentration ratio of purple sweet potato and cassava, namely 5 parts purple sweet potato: 1 part cassava.

The results of the antioxidant activity test also showed that the addition of cassava in the manufacture of purple sweet potato tortillas greatly affected the antioxidant activity, where there was a significant decrease in antioxidant activity with the higher concentration of added cassava (Figure 2).

Moisture Content

The results of the analysis of variance showed that the ratio of the concentration of raw material for purple sweet potato and cassava had a very significant effect (Fhit = 47.98> Ftab (α = 0.1) = 4.25) on the water content of tortilla products. Based on Figure 3, it can be seen that the lowest average water content value of 2.43% is found in tortilla products with a concentration of 1 part purple sweet potato, while the highest average total sugar value of 5.63% is found in tortilla products with a concentration of 5 parts of purple sweet potato.

The data trend in Figure 3 shows that the higher the concentration of purple sweet potato added will increase the water content in the tortilla product.

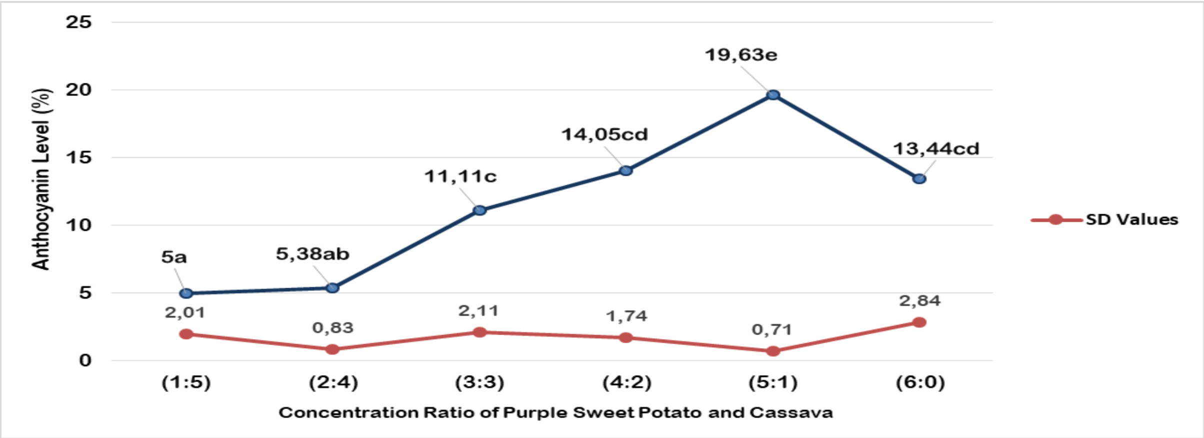

Figure 1. Athocyanin Levels of purple Sweet Potato Tortillas

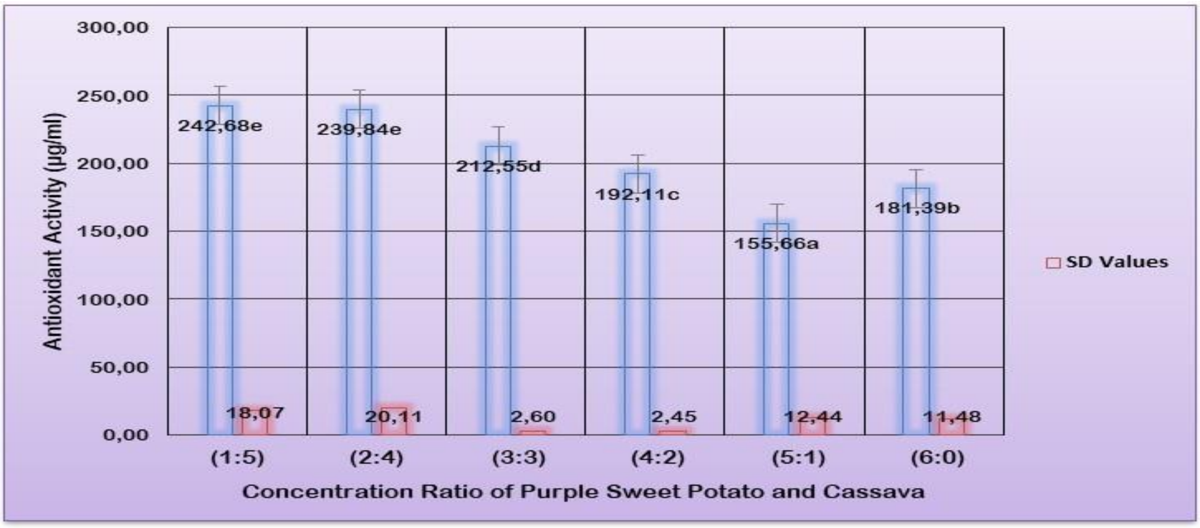

Figure 2. Antioxidant Activity of purple Sweet Potato Tortillas.

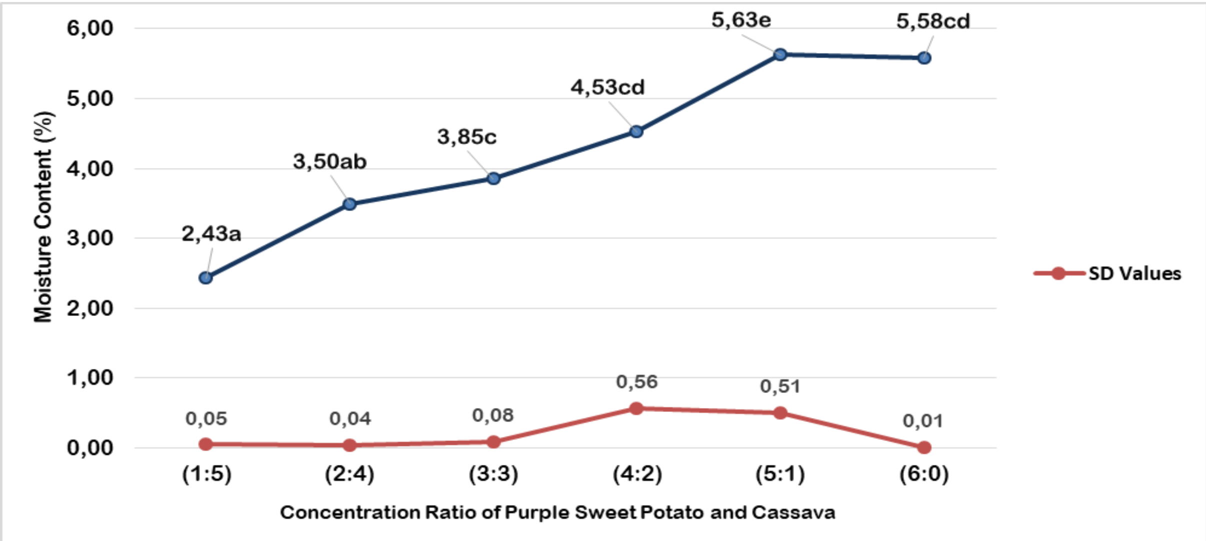

Figure 3. Moisture Content of purple Sweet Potato Tortillas.

Crude Fiber Content

Dietary fiber is a carbohydrate that cannot be digested by enzymes in human digestion and eventually reaches the large intestine. Natural oligosaccharide fibers stored in sweet potatoes become valuable commodities in the enrichment of processed food products. The fiber content functions as a non-nutritional component, but is beneficial for the balance of the intestinal flora and as a prebiotic, stimulates bacterial growth which is good for the intestine so that the absorption of nutrients is better and the intestine is cleaner (Susilowati, 2010).

The results of the analysis of variance showed that the ratio of the concentration of raw material for purple sweet potato and cassava had a very significant effect (Fhit = 161.01> Ftab (α = 0.1) = 4.25) on the crude fiber content of tortilla products. Based on Figure 3, it can be seen that the lowest average fiber content value of 3.768% is found in tortilla products with a concentration of 1 part purple sweet potato, while the highest average total sugar value of 9.696% was found in tortilla products with a concentration of 6 parts of purple sweet potato.

From Figure 4, it can be seen that the higher the concentration of purple sweet potato added, the higher the crude fiber content of the tortilla.

Total Sugar Content

Sweet potato and cassava are foodstuffs that are high in carbohydrates and dietary fiber. Carbohydrates are one of the macro nutrients that function as fuel (energy sources) to be used by the body, where these nutrients can be classified into three types, namely starch, fiber and sugar.

The analysis of variance showed that the ratio of the concentration of raw material of purple sweet potato and cassava had a very significant effect (Fhit = 4.780> Ftab (α = 0.1) = 2.277) on the total sugar of tortilla products. Based on Figure 5, it can be seen that the lowest average total sugar value of 0.652% is found in tortilla products with a concentration of 1 part purple sweet potato, while the highest average total sugar value of 1.077% is found in tortilla products with a concentration of 5 parts of purple sweet potato.

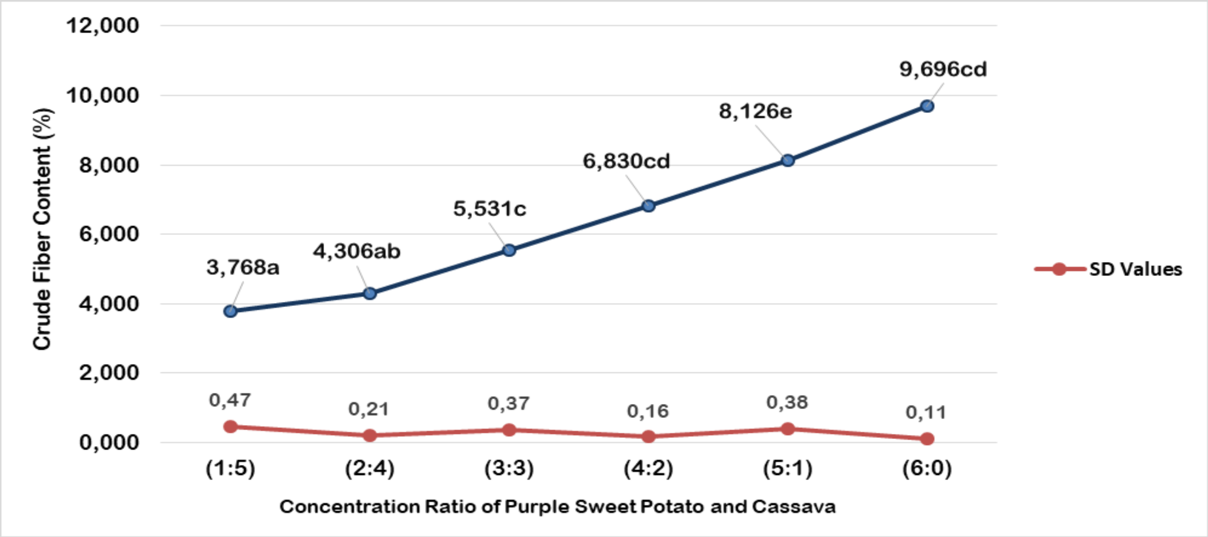

Figure 4. Crude Fiber Content of purple Sweet Potato Tortillas..

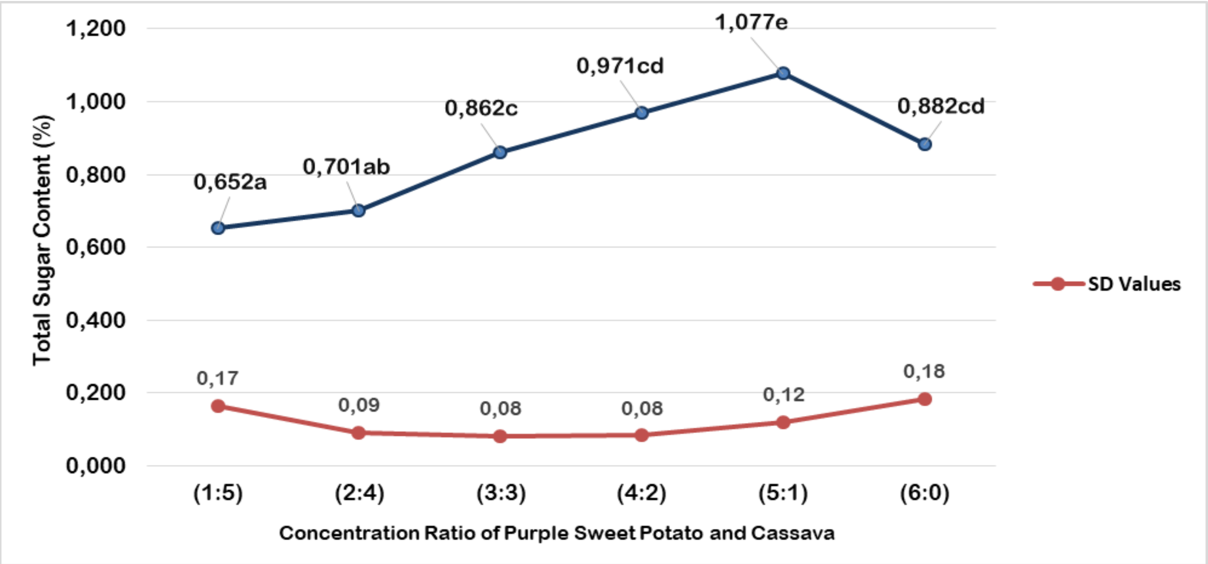

Figure 4. Total Sugar Content of purple Sweet Potato Tortillas.

Discussion

Purple sweet potato has the advantage of anthocyanin content that reaches 80-98% (Li et al, 2013), where this anthocyanin is one of the natural pigments in food that has many functions such as antimutagenic (Yamakawa & Yoshimoto, 2001), anti-carcinogenic and radical deterrent. free (antioxidants) (Jusuf et al, 2008).

The results showed that there was a very significant decrease in anthocyanin levels of purple sweet potato tortillas when compared to anthocyanin levels in fresh purple sweet potato (61.85%). The percentage of reduction varied from 68.26 to 91.91%.

The graph of anthocyanin levels in Figure 1 shows that the higher the concentration of purple sweet potato added, the smaller the percentage decrease in anthocyanin levels.

This is because purple sweet potato is one of the largest sources of anthocyanin food, because in its fresh form alone, purple sweet potato contains 61.85 mg / 100 g of anthocyanins (processed data, 2020), according to Pokarny et al (2001), the number of anthocyanins in purple sweet potato is 519 mg /100 g of material, and has antioxidant activity, where the antioxidant activity of purple sweet potato is much stronger than red sweet potato.

From Figure 1 it can also be seen that the higher the concentration of cassava added, the lower the tortilla anthocyanin content. This is due to the high binding capacity (encapsulation) of starch from the cassava which increases the number of solids (starch/carbohydrate concentration) so that it will indirectly (relatively) reduce tortilla anthocyanin levels. According to the research of Wiriani et al (2020), where an increase in the concentration of maltodextrin resulted in a decrease in the levels of anthocyanin microencapsulate anthocyanins from the liquid waste of purple sweet potato.

This is also in line with the research of Padzil et al (2018) which showed a decrease in anthocyanin levels with increasing concentrations of maltodextrin.

Furthermore, Yudiono (2011) stated that the drying temperature reaching 150ºC can also cause the release of the glycosyl part of the anthocyanin where the glycosidic bonds will be hydrolyzed to form unstable aglycones and anthocyanins lose color.

It is directly proportional to anthocyanin levels, it can be seen from Figure 2 that there is a significant decrease in antioxidant activity with the increasing concentration of added cassava. This is because the higher the concentration of cassava means the higher the amount of solids (starch) results in a decrease in anthocyanin levels so that antioxidant activity also decreases or weakens. According to the research of Wiriani et al (2020), the higher the concentration of maltodextrin, the lower the antioxidant activity of anthocyanin microencapsulated purple sweet potato liquid waste which is indicated by an increase in the IC_{50} value.

According to Phongpaichit et al (2007), a compound is declared as free anti-radical is very strong if the IC_{50} value is <10 µg/ml, strong if the IC_{50} value is between 10-50 µg/ ml, moderate if the IC_{50} value ranges from 50-100 µg/ml, weak when the IC_{50} value ranges from 100-250 µg/ml and is inactive when the IC_{50} is above 250 µg/ml. Based on the opinion, the purple sweet potato tortilla product in this study was stated to have weak antioxidant activity because the IC_{50} value ranged from 155.66 - 242.68 µg/ml.

The weak antioxidant activity of purple sweet potato tortillas in this study was due to the low levels of anthocyanins (antioxidant compounds) contained in the tortillas, a result of the use of high temperatures in processing such as steaming, drying, and frying.

Tristantini et al (2016), suggest that too long drying time will affect the IC_{50} value because if the active substance in the sample is exposed for a long time to high temperatures it will damage the antioxidant components so that the IC_{50} value becomes high which means that the antioxidant activity is getting weaker.

The concentration ratio of raw materials used in this tortilla product also greatly affects the water content, crude fiber content and total sugar content of the tortilla, where the higher the concentration of purple sweet potato added will increase the moisture, fiber and sugar content in the tortilla product.

This is because sweet potatoes in their fresh form (68.5%) have a higher water content than cassava (62.5%) (Muchtadi and Ayustaningwarno, 2010), besides Widowati and Wargiono (2009) suggest that fresh sweet potatoes are also has more fiber content (7.96%) than fresh cassava (6.97%), so that the additional concentration of purple sweet potato used will increase the fiber content of the tortilla, which results in increased water content because the fiber has the ability to bind water with strong.

Muchtadi (2013) states that fiber has the ability to bind water, so water that is tightly bound in food fiber is difficult to be evaporated again even with the drying process.

Susilawati et al (2014) further stated that sweet potato is one of the foods that contain lots of sucrose (sugar), where the sugar content can reach 5.64 - 38% (b/b), and the cooking process will increase the amount of sugar in the sweet potato, if compared to fresh sweet potatoes, in the graph (Figure 5) it can be seen that the higher the concentration of purple sweet potatoes, the higher the total sugar content in the tortillas.

CONCLUSIONS AND SUGGESTIONS

Conclusions

The ratio concentration of 5 parts of purple sweet potato and 1 part of cassava is the best tortilla raw material composition compared to other combinations because it can produce tortillas with the highest anthocyanin content of 19.63% and the strongest antioxidant activity (lowest IC_{50}) of 155.66 µg/ml. Other than that, this treatment also showed a water content of 5.63%, fiber content of 8.126% and total sugar of 1.077%.

Suggestions

Modification of the tortilla processing process needs to be carried out, especially in processes that use high temperatures, such as the steaming process of fresh purple sweet potato and the drying process. The method applied can reduce the exposure of active substances (anthocyanins) in samples to high temperatures to reduce the level of damage.

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