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by Kukuk Yudiono

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EFFECT OF STORAGE TEMPERATURE TO ANTHOCYANIN RENDEMENT OF PURPLE SWEET POTATO

Kukuk Yudiono[1].

[1]Department of Agricultural Product Technology, Faculty of Agriculture, Widya Karya Catholic University, Malang 65115, East Java, Indonesia
E-mail: kukuk@widyakarya.ac.id

ABSTRACT

Purple sweet potato is one commodity with an important compound which is anthocyanin. Anthocyanin is a natural pigment which in the food industry can be used as a functional material, among others, as a natural dye. This study aims to determine the effect of storage temperature and storage time of purple sweet potato anthocyanin rendement.

The sweet potato tubers of Ayamurasaki variety are harvested from Balitkabi Malang. The research uses a Completely Randomized Design (CRD) with two factors that is: storage temperature, using two levels (10°C and 28°C) and storage time using four levels (1 day , 7 day, 21 day, and 35 day).

The results show that the content and rendement of anthocyanin at 10°C and 28°C storage temperature for 35 days increased. At 10°C storage temperature after the end of storage the content and anthocyanin rendement were higher ie 142.078 mg / 100 g and 33.500%. The conclusion of this study is, that storage at 10°C for 35 days response in anthocyanin content of +47.36 mg / 100g and antocyanin content response of +6.7% higher than that stored at room temperature (28°C) with antosianin content response of +43.386 mg / 100 g and anthocyanin rendement response of +4.02%.

KEYWORDS

purple sweet potato, anthocyanin, temperature storage, storage time

INTRODUCTION

The use of synthetic coloring in food products is unsafe since they contain heavy metals, such as lead, which are harmful to health as they could trigger lethal diseases such as tumors and cancer. According to WHO (2014), cancer cases were expected to experience 57% surge worldwide in the next 20 years; it is further stated that new cancer cases would rise from about 14 million to 22 million within two decades and cancer deaths were expected to increase from 8.2 million to 1 million annually. It is estimated that by 2030 there will be an increase of cancer patients in Indonesia by seven times and it is estimated that there will be 100 new cases per 100,000 people each year. This means that of 237 million people there will be approximately 237,000 new cancer patients per year (Kartika, 2013). The long-term purpose of this research is to determine bioactive compounds contained in the anthocyanin which could serve as anti-cancer.

When there is abundance in sweet potato production, excess products that the farmers are unable to sell or are unprocessed are usually put into storages. Economically, storage aims to maintain the quality of sweet potatoes for a certain time so that the price does not fluctuate from one harvest to the next. In addition, many harvested sweet potatoes require time for sorting before being sent to the food processing industry, as a result the tubers can not directly be processed products in one production. The shelf life can be extended by cooling method, and this method is a practical and economical way for long-term storage for fresh commodities, including sweet potatoes.

Purple sweet potato is one commodity that has an important compound that is anthocyanin. Anthocyanin is a natural pigment which in the food industry can be used as a functional material, among others, as a natural dye. In recent years considerable attention has been focused on the potential beneficial effects on human health of anthocyanins and their derived compounds. Such benefits include free radical scavenging and antioxidant activity, antimicrobial and antiviral activity, prevention of cardiovascular disease, protective effect against hepatic damage and disease, anticancer and antimutagenic activity, and so on (Bitsch *et al*., 2004; Jing *et al*., 2008). On the other hand, with no literature reports of anthocyanin toxicity their safety has been extensively demonstrated by the widespread consumption of food products that contain anthocyanins (Mondello *et al*., 2000). Because of their brilliant color, high water solubility and beneficial biological properties, anthocyanins are considered as a class of potential natural pigments to replace the synthetic colorants in many kinds of food (Camire *et al.*, 2002).

The purple sweet potato is a perishable commodity and is not available at all times. So as to maintain the availability of purple sweet potato especially the anthocyanin pigment, an appropriate storage method is required. This study aims to determine the effect of storage temperature and storage time of purple sweet potato anthocyanin rendement.

According to Ayala-Zavala (2004) a good condition for storage is in cold conditions that will have a positive effect on the content of antioxidants contained in fruits. Phenolic compounds including anthocyanins are strongly associated with antioxidant activity, antioxidants will increase when the levels of polyphenol compounds increase. This increase in phenolic compounds is associated with an increase in the enzyme phenylalanine ammonia-lyase (PAL) which is one of the important enzymes in the synthesis of phenolic compounds (Padda and Picha, 2008).

Anthocyanins are not always synthesized under normal growth conditions.They are able to respond to environmental stress,such as light, nutrient depletion, and low temperature. Low temperature stress is an important factor inincreasing anthocyanin production (Zhang *et al.*, 2012). In addition, the anthocyanin accumulation in the purple kale is strongly induced by the low temperature stress. The total anthocyanin contents in the purple kale under low temperature were about 50 times higher than the plants grown in the green house. Research in Arabidopsis seedlings showed that significant Anthocyanin accumulation was induced by low temperature treatment through the up-regulation of CHS (chalcone synthase), CHI (chalcone isomerase) and F3H (flavanone 3-hydroxylase) (Zhang *et al.* 2010). In addition Deiting et al. (1998), potato tuber storage at cold temperatures can increase sugar content. Furthermore Asgar and Rahayu (2014) stated that the reducing sugars accumulated in potato tuber tissue stored at higher temperatures are due to the presence of SPS (Sucrose Phosphat Synthase) enzyme activity.

MATERIALS AND METHODS

The raw material employed is sweet potato tubers of Ayamurasaki variety harvested from Research Center for Assorted Beans and Tuber Crops's (Balitkabi's) experimental field in Malang, Indonesia (during the dry season). The research uses a Completely Randomized Design (CRD) with two factors that is: storage temperature, using two levels (10^{o}C and 28^{o}C) and storage time using four levels (1 day , 7 day, 21 day, and 35 day). Observation variables include total anthocyanin content, anthocyanin rendement, respon of content and rendement anthocyanin. The statistical analysis employed to find out the effects of the treatment was the analysis of variance (ANOVA), using the *Design Expert 7.0.0* program; treatments were differentiated when p-value < 0.05, but no differentiation was made when p-value > 0.05.

Extraction of anthocyanin and analysis of anthocyanin levels using rapid quantification method (Aal and Hucl, 1999)

Three grams of Ayamurasaki purple sweet potato samples were blended and weighed, next 24 ml ethanol 96% was added (1:8), then the whole mixture was acidified (ethanol : HCL 1.0 N = 35:15), and finally stirred for 15 minutes using magnetic stirrer. Once completely blended, the mixture was centrifuged at 4000 rpm for 15 minutes until a supernatant was obtained. The supernatant was poured into a 50 ml flask, filtered through a Whatman filter paper to obtain the filtrate/concentrate of pulp-free anthocyanin. Next, acidified ethanol was added to the filtrate until 50 ml volume was achieved. Nitrogen was blown over the bottled filtrate/concentrate to eliminate oxygen in the head space, and then it was stored in the refrigerator with 4°C temperature until it was ready for analysis for: total anthocyanin, antioxidant activity, anthocyanin profile, and color size.

Total anthocyanin (Aal and Hucl, 1999)

Four ml of the filtrate/concentrate were taken and its absorbance was measured at 532 nm wavelength.

Total anthocyanin calculation:

$C = (A/e) \times (vol/1.000) \times MW \times (1/sample\ weight) \times 10^6$ ………………… (1)

C = concentration of total anthocyanin (mg/kg)
A = reading of absorbance
e = molar absorptivity (cyanidin 3-5-diglucoside = 25.965 L/mol)
Vol = total volume of anthocyanin extract in 50 ml flask
MW = the weight of the molecules of cyanidin 3-5-diglucoside (449)

Anthocyanin rendement :

$$\text{Anthocyanin rendement (\%)} = \frac{\text{Anthocyanin filtrates (g)}}{\text{Sample weight (g)}} \times 100\% \quad \text{.................. (2)}$$

Response during storage *:*

Antocyanin content response = X1 – Xn ……………………………………………. (3)

X1 = total anthocyanin at the first day of storage
Xn = total anthocyanin at the end of storage

Anthocyanin rendement response :

Response anthocyanin rendement = R1 – Rn ……………………………………….. (4)
R1 = anthocyanin rendement at the first day of storage
R2 = anthocyanin rendement at the end of storage

RESULTS AND DISCUSSIONS

The results show that storage time and methods of treatment have a significant effect (p-value < 0.01) of anthocyanin content and anthocyanin rendement. The mean values of anthocyanin content and anthocyanin rendement in the treatment of temperature and storage time are as shown in Table 1 and Table 2 below:

Tabel 1. Mean values of anthocyanin content (mg / 100 g) in the treatment of temperature and storage time

Storage Temperature	Storage Time				Response
	1 day	7 day	21 day	35 day	
10°C	94.718 [a]	117.931 [b]	128.836 [d]	142.078 [e]	+47.360
28°C	95.965 [a]	127.015 [c]	129.225 [d]	139.351 [f]	+43.386

*) means followed by same superscript in one column was significant diference (*p-value*<0.05) and means were measurement from three different samples.

Tabel 2. Mean values of anthocyanin rendement (%) in the treatment of temperature and storage time

Storage Temperature	Storage Time				Response
	1 day	7 day	21 day	35 day	
10°C	26.800 [a]	27.470 [b]	30.150 [b]	33.500 [d]	+6.70
28°C	26.800 [a]	23.450 [a]	31.490 [c]	30.820 [b]	+4.02

*) means followed by same superscript in one column was significant diference (*p-value*<0.05) and means were measurement from three different samples.

Table 1 and Table 2 shows that the content and rendement of purple sweet potato anthocyanin increased at 10°C and 28°C storage temperature for 35 days. Tukey test (5%) showed that the highest anthocyanin content and anthocyanin rendement occurred at 10°C storage temperature on day 35. At 10°C storage temperature after the end of storage the anthocyanin content were higher ie (142.078 mg / 100 g) than the 28°C (139.351 mg/100 g). As well at 10°C storage temperature after the end of storage the anthocyanin rendement were higher ie (33.500%) than the 28°C (30.820 %) . Because of the sweet potatoes at low temperatures precisely increased the activity of enzymes forming phenolic compounds primarily flavonoid compounds whose majority are anthocyanin. The increase in the sweet potato tubers' anthocyanin content and anthocyanin rendement as long as it is stored primarily at low temperatures is assumed to be due to the increase of enzymes' activities in the ingredients, including that of the anthocyanin-forming enzymes such as PAL (phenylalanine ammonia lyase) enzyme. The results of the study of Kubasek *et al.* (1992) suggested that the anthocyanin pigments of the Arabidopsis seeds occurred after sprouting, which was related to the increased mRNA coded by 4 flavonoid biosyntheses such as PAL7 (encoding fenilalaninamonia-liase I), CHS (encoding chalcone synthase), CHI (encoding chalcone isomerase), and DFR (encoding dihydroflavonol reductase).

In addition, in the visual observation after the fifth day revealed that germination was beginning to occur in on the tubers, the activity in the germination process is also the cause of increased content and anthocyanin rendemen. Germination will lead to increased activity of various enzymes, including enzymes that have an effect on antioxidant activity. Yudiono (2011) states that the increase in antioxidants is influenced by an increase in the content of purple sweet potato anthocyanins. Further, the germination process with antioxidant activity is also reported the results of previous study (Begam and Sharanavan 2011, Suryanti *et al.*, 2016, Jirapa *et al.*, 2016, and Phattayakorn *et al.*, 2016), despite using different commodities (groundnut arachis H., Leucaena L ., and Paddy rice). The results of these studies show that the commodity undergoing germination will increase its antioxidant activity. The increase of antioxidant capacity is allegedly due to the increased activity of enzymes involved in the capture of free radicals and peroxides. According to Parmooon *et al.* (2013) the enzyme playing the role in the capture of free radicals and peroxides are superoxide dismutase (SOD). This is supported by the results of the research of Vichit and Soewan (2016) in which, the SOD of rice that undergoes germination 3 times higher than those not experiencing germination.

In addition, the increase in purple potato's sugar content during low temperature storage, as reported by Merianti and Yudiono (2015), is also the cause of anthocyanin increase as anthocyanin is composed of the aglycon group (a non-sugar group) is called an anthocyanidin (pelargonidin, cyanidin and delphinidin) with the glycon group (sugar group) present as a glycoside series (glucose, fructose or ramnose), so that the more sugar that is formed will increase the composition of anthocyanin compounds. Furthermore Asgar and Rahayu (2014) stated that reduced sugars accumulated in potato tuber tissue stored at cold temperatures are higher than at room temperature, due to increased activity of SPS enzymes (sucrose phosphat synthase).

CONCLUSIONS

The conclusion of this study is that during the storage of purple sweet potato the rendement and the content of anthocyanin increased. During storage at 10°C for 35 days the response in anthocyanin content is +47.36 mg / 100g and antocyanin content response is +6.7% higher than those stored at room temperature (28°C) with antosianin content response +43.386 mg / 100 g and anthocyanin rendement response of +4.02%.

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