Effects of Cooking on Yield, Total Carotenoid, and Color of Long, Cone-shaped Tongkalangit Banana (*Musa Troglodytarum*) Puree

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Keywords: Cooking, Color, TongkaLangitBanana, Total Carotenoid, Yield.

Abstract: This study aimed to determine the yield, total carotenoid content, and colour of the long, cone-shaped tongkalangit banana (*Musa troglodytarum*) puree with different cooking methods and time. Six levels of treatments, i.e. control, steaming 5 mins, steaming 10 mins, boiling 5 mins, boiling 10 mins, grilling 5 mins, and grilling 10 mins were applied in this particular study. Results showed that the highest yield of puree obtained when the banana was grilled for 5 mins (69.93%), and the highest total carotenoid content in puree was found to be 162.92 ppm (grilling 10 mins). The longer was the cooking time; the higher was the total carotenoid content for each cooking method. The degree of redness (a value) and yellowness (b value) of the puree showed a similar trend. The longer the banana was steamed and boiled, the lower was its redness and yellowness. On the contrary, the values increased along with increasing grilling time.

1 INTRODUCTION

Banana is considered a sought-after fruit due to its popularity in the world market and its importance as a food crop after rice, wheat, and maize. It is mostly grown in more than 130 tropical and subtropical countries. Banana is the fruit of evergreen monocotyledonous, perennial, giant herb, exclusively subtropical belonging to the genus Musa from the family Musaceae (Singh *et al*., 2016). One essential species of bananas in eastern Indonesia, especially the Moluccas, is Fe'i banana, locally known as "pisang tongkalangit" (*Musa troglodytarum* L.), bananas with erect bunches facing up the sky.

Fe'i bananas are mostly originated from the Moluccas, eastern Indonesia in the west, and found as far as French Polynesia in the east (Ploetz *et al*., 2007). The tongkalangit bananas belong to Fe'i bananas have erect bunches and can be recognized by their bright magenta to dark purple sap, heavily ridged squarish red or coppery fruit, and near glowing orange or yellow fruit flesh (Ploetz *et al*., 2007). In the Moluccas, there are two types of "tongkalangit" banana: long fruit, cone-shaped bunch, and short, small, round-shaped fruit. The long tongkalangitbanana similar to*UtinIap*(*Uhten Yap)*, and the short tongkalangit banana similar to "*Karat Pwehu"*in Micronesia (Englberger *et al*., 2006).

The fruit of some clones is exceptionally high in beta carotene. In Micronesia,*Uhten Yap*contains 6,110 µg of β-carotene/100 g, which is 275 times the level noted for Cavendish. The Pohnpei Karat banana, a traditional weaning food in the Federated States of Micronesia, contains 867 µg of β-carotene/100 g (Englberger *et al*., 2003). Epidemiological studies have shown that foods containing high carotenoids are adequate protection against chronic disease, including certain cancers, cardiovascular disease, and diabetes (Englberger *et al*., 2003). Also, carotenoids can be used as a natural colorant in the food industry. Tongkalangit banana, if consumed, will turn the urine bright yellow, very bright saffron yellow, and was documented in Mollucas of Indonesia in 1750 (Sharrock, 2001). This phenomenon was confirmed by Engelberger*et al*. (2006) that high levels of riboflavin content in the*Karat*bananas, which caused the urine to turn bright yellow after they are consumed.

As a food, Tongkalangit bananas usually must be cooked, because even if the fruit is ripe, the unpleasantly astringent after-taste is still present. They are usually cooked either by roasting, grilling, boiling or steaming. The flesh, even after cooking, is

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Moniharapon, E., Tuhumury, H. and Souripet, A.
Effects of Cooking on Yield, Total Carotenoid, and Color of Long, Cone-shaped Tongkalangit Banana (Musa Troglodytarum) Puree.
DOI: 10.5220/0010542000003108
In *Proceedings of the 6th Food Ingredient Asia Conference (6th FiAC 2020) - Food Science, Nutrition and Health*, pages 122-126
ISBN: 978-989-758-540-1

commonly fed to infants at the time of weaning. Provided the significant health benefits of tongkalangit bananas, their importance has declined considerably in Mollucas, and it becomes considerably hard to find these bananas in traditional markets. Therefore, efforts are necessarily needed to maintain the existence of these bananas. One of which is developing and marketing food products of nutrient-rich of these bananas cultivars and banana puree is one of the value-added products that can be applied to tongkalangit bananas.

Banana Puree is a banana that has been pressed, ground, and blended into a soft, creamy paste or thick liquid. The banana puree has a longer shelf life than the raw fruit and is the main commercial processed banana product and has been widely utilized worldwide. The puree can be used as an ingredient for many foods such as baby food, juice and smoothies, dairy (yogurt, ice cream, pudding), and bakery (cake, bread, pie, etc.) (Ditchfield *et al.*, 2004; Pandita, 2018;Yap *et al.*, 2017). Banana puree prices have been increasingly followed by an upward trend recently, with a significant increase in early 2010. These prices have been unaffected by instabilities in raw banana prices. The global banana puree market is expected to gain annual growth of 4.8% from 2017-2027 (Pandita, 2018). Therefore, tongkalangit banana, with its specific competitive advantages compared to other bananas, is feasible to be processed into a puree. However, several factors need to be considered in making puree, such as this banana's cooking process, since it is not usually consumed raw but cooked.

Generally, the process of making banana puree includes blanching, mashing, preserving, and packaging. Yap et al. have indicated that Cavendish banana with a maturity index of 5 out of 7 banana ripening stages resulted in puree having the best characteristics. Blanching time also has a significant effect on the color of the banana puree (Palou *et al.*, 1999). The viscosity and rheological characteristics of puree were influenced by heating. When banana was heated with increasing temperature from 50°C to 60°C and from 110 °C to 120°C, the apparent viscosity was found to be increased (Ditchfield *et al.*, 2004). Hence, this study was aimed to determine the effect of the cooking method on yield, total carotenoid, and color of long cone-shaped tongkalangit banana puree.

2 MATERIALS AND METHODS

2.1 Materials

Long tongkalangit bananas were harvested from Siwang village in Ambon Island, Mollucas, Indonesia. The color of the fruit flesh determined the degree of maturity of the bananas. The color was determined by using an egg yolk color chart (Robotmation, Co., Ltd, China) based on the method described by Engelberger*et al*. (2006). The banana was used in this study with the maturity of 10 days after harvest matching the egg yolk color number 10.

2.2 Methods

2.2.1 Banana Puree Production

The unpeeled tongkalangit banana with a maturity of 10 days after harvest was subjected to different cooking methods and times, i.e., steaming, boiling, and grilling each for 5 minutes and 10 minutes. The cooked banana with each cooking method was placed in the ice water for 5 mins then peeled and pureed to a smooth consistency by passing them through a 60 mesh sieve (Gilson. Inc., USA). The puree was then packed into plastic bags, sealed, and stored at 3° C until required for analysis.

2.2.2 Yield

The yield of the puree was determined as the percentage of the puree weight over the weight of the banana fruit.

2.2.3 Total Carotenoid Content

The extraction of carotenoids was conducted by adding 25 mL acetone successively until a paste was obtained. The paste was transferred to a sintered funnel coupled to a 250 mL Buchner flask and filtered under vacuum and repeated three times. The obtained extract was transferred to a 500 mL separatory funnel containing 40 mL of petroleum ether. The acetone was removed through a slow addition of MiiliQ water to prevent emulsion formation. The aqueous phase was removed, repeated until no residual solvent remained. The extract was transferred with a funnel to a 50 mL volumetric flask containing 15 g of anhydrous sodium sulfate. The final volume was adjusted with petroleum ether, and samples were analyzed at 450 nm. The total carotenoid content was calculated using a formula:

$$Total\ carotenoid = \frac{A\ \times V\ (mL) \times 10^4}{A^{1\%}_{1\ cm} \times P(g)}$$

Where A : absorbance; V = total extract volume; P = sample weight and $A^{1\%}_{1\ cm=}$extinction coefficient 2592

2.2.4 Colour

The color of the puree was determined using a Minolta Colorimeter (CM 508i, Minolta Corp, Japan). Values were recorded in terms of CIE values (CIE-Lab), where L represents brightness from black (0) to white (100), a represents green to red (-80 to +80), and b represents blue to yellow (-80 to +80). The Colorimeter was standardized with the black and white calibration tiles before each measurement. The color was measured on three random points of the pack.

2.2.5 Statistical Analysis

The data collected were analyzed using ANOVA for a completely randomized experimental design. The means of treatment showing significant differences ($p < 0.05$) were subjected to the Tukey test. These analyses were performed using a statistical software MINITAB version 17.

3 RESULTS AND DISCUSSION

3.1 Yield

The yield of the tongkalangit banana puree is summarized in Figure 1. The data indicated that the lowest yield was obtained for puree steamed for 10 minutes (53.41%), whereas the highest was puree, which was grilled for 5 minutes (69.93%). Previous results on Ambon banana puree has shown that the yield obtained was in the range of 62.78-65.85%. Data also indicated that the longer the cooking time, the lower was the yield. Boiling and steaming the banana has resulted in lower yield than grilling because of these respective cooking methods involving water has caused the loss of some soluble solids. One main disadvantage of cooking involving water is leaching nutrients and other water-soluble components and causing a decrease in total soluble solids (Quarcoo and Wireko-Manu, 2016); hence the yield would also decrease.

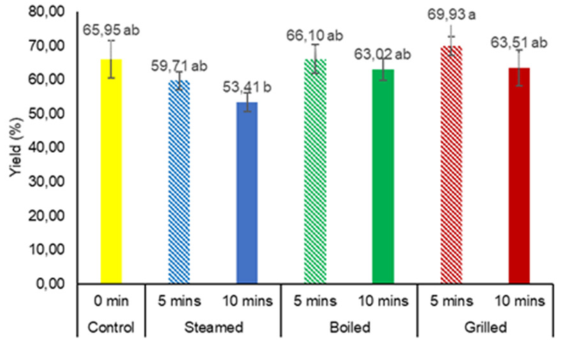

Figure 1: Yield of Long Cone-shaped TongkaLangit Banana Puree.

3.2 Total Carotenoid Content

Figure 2 shows the total carotenoid content of tongkalangit banana puree with different cooking methods. Overall, boiling and grilling increased the puree's total carotenoid content compared to the raw banana puree. At the same time, the carotenoid content was found to decrease as the banana was steamed. The longer the cooking time, the higher the carotenoid content for all cooking methods applied. The highest carotenoid content was obtained for grilling, either 5 minutes or 10 minutes.

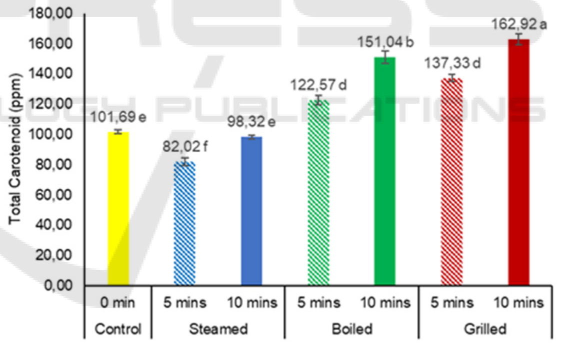

Figure 2: Total Carotenoid Content of Long Cone-shaped TongkaLangit Banana Puree.

The results were in accordance with previous studies showing that thermal processing has caused the increase in carotenoid content of tomato, carrot, and banana (Dewanto *et al*., 2002: Sánchez-Moreno *et al*., 2006: Palmero *et al*., 2014: Fu *et al*., 2019). Processing such as heat treatment or mechanical homogenization has the potential to enhance the bioavailability of carotenoids. Carotenoids are tightly bound to macromolecules, in particular to protein and membrane lipids. Therefore, processing methods that affect macromolecular structures such as proteins and polymer carbohydrates can increase carotenoid content.

Table 1: Color of TongkaLangit Banana Puree with Different Cooking Methods.

Treatments	Color		
	L	a	b
Control	54.59 ± 3.21 [a]	0.10 ± 0.02 [d]	30.63 ± 1.44 [bc]
Steamed 5 mins	51.96 ± 3.41 [a]	2.92 ± 0.29 [bc]	32.46 ± 0.29 [b]
Steamed 10 mins	51.44 ± 1.73 [a]	2.89 ± 0.13[bc]	30.53 ± 0.56 [bc]
Boiled 5 mins	52.16 ± 1.48 [a]	2.96 ± 0.11 [b]	29.87 ± 0.42 [c]
Boiled 10 mins	52.72 ± 1.70 [a]	2.64 ± 0.15 [bc]	29.06 ± 0.35 [cd]
Grilled 5 mins	51.41 ± 3.13 [a]	2.31 ± 0.13 [c]	27.11 ± 0.33 [d]
Grilled 5 mins	53.91 ± 1.29 [a]	3.95 ± 0.16 [a]	35.21 ± 0.13 [a]

Means within a column with the same letter are not significantly different ($p < 0.05$)

Grilling might cause the interruption greater than steaming and boiling, hence the higher the bioavailability of the carotenoids.

3.3 Colour

The lightness (L Value) of the puree was not significantly affected by cooking methods, but the degree of redness (a) and yellowness (b) was significantly affected (Table 1). Data indicated that the cooking method increases the puree's redness, yet decreases the yellowness of the puree compared to the control.

When banana was steamed and boiled, the redness and the puree's yellowness decreased as the time increased. On the other hand, the puree's respective a and b value increased with longer grilling time.

No significant difference in the L values indicated that the different cooking methods did not cause any enzymatic browning. The puree did not become darker and still maintain the color similar to the puree from raw banana. The increase in the redness and decrease in yellowness was due to cooking. When cooked, a non- enzymatic browning happened through several biochemical reactions, including the Maillard reaction, pigment destruction, and caramelization of sugar (Chakraborty *et al*., 2015). However, longer steaming and boiling decrease the redness and yellowness, while increase when grilled. This is because caramelization and browning can only happen in a dry heat cooking environment. The highest temperature water can reach 100° C, which is not hot enough to pyrolyze sugars and protein. Thus, limited caramelization happened by steaming, boiling, or anything that involves cooking it in liquid.

4 CONCLUSIONS

The highest yield of puree obtained when the banana was grilled for 5 mins (69.93%), and the highest total carotenoid content in puree was found to be 162.92 ppm (grilling 10 mins). The longer was the cooking time, the higher was the total carotenoid content for each cooking method. The degree of redness (a value) and yellowness (b value) of the puree showed a similar trend. The longer the banana was steamed and boiled, the lower was its redness and yellowness. On the contrary, the values increased along with increasing grilling time.

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