

Effect of Method and Ripening Duration on the Content of β -Carotene of Fe'i Banana (*Musa troglodytarum* L.)

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Abstract

Research was conducted to determine the effect of the method and duration of ripening on the content of β -carotene of Fe'i banana, as well as determine the method and duration of ripening is effective in maintaining the nutritional value of Fe'i Banana. Through laboratory experimental with randomized complete design consisting of 19 groups of treatments and three repetitions, the data obtained were analyzed using statistical tests ANOVA and continued with Duncan test. Results of the analysis showed that method of ripening statistically significant difference ($p < 0,05$) on the content of β -carotene in the banana sticks sky. Long ripening length statistically significant difference ($p < 0,05$) on the content of β -carotene in the Fe'i Banana. Grilled ripening method is more effective against β -carotene content in the Fe'i Banana and takes 10 minutes of ripening length more effectively on the content of β -carotene on a Fe'i Banana.

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Introduction

One type of banana that is known comes from the Moluccas, Indonesia is Fe'i banana (*Musa troglodytarum* L.). Moluccas people call it by the name "pisang tongkat langit" or "banana pointing to the sky", as bunches of fruit that grow upright towards the sky (Ploetz *et al.*, In Hiariej, 2013). Heyne in Samson *et al.* (2013) describe the skin texture of the Fe'i banana is reddish with black spots, while orange-yellow flesh.

Society found that eating Fe'i Banana to improve kidney function, help reduce fever, as well as enhancing stamina of men, although not yet in clinical trials (Samson *et al.*, 2013). In addition, they also believed that Fe'i Banana is good to be given to infants. Bananas are often used as complementary feeding (MP-ASI) by the mother because the texture of the fruit is easily digested by the baby just learning to eat solid food.

Based on the research results, obtained information Fe'i Banana fruit contain carotenoids, and β -carotene is more dominant (Samson *et al.*, 2013). Provitamin A and total carotenoids were high at 6360 mg/100 g was found in bananas (Englberger *in* Samson *et al.*, 2013). According Almatsier, Suhardjo and Kusnarto *in* Naid *et al.* (2012), β -carotene is a

provitamin A plant pigment and is most important for humans as it can form two molecules of vitamin A. Vitamin A is considered to have protective effect in cancer prevention, cardiovascular disease, cataract and macular and neurologic diseases, inflammatory and immune disorders (Kidmose *et al*; Arora *et al.*, in Fungo & Pillay, 2011).

For the purposes of consumption, usually people do certain ripening way to food. From a number of ripening techniques that are commonly used, the technical term grilling and steaming techniques. The method is to cook with grilling. It is a way of ripening using indirect heat (burns) and the process is faster because the food was burnt near the source of the fire. Steaming or usually known as steaming is damp or wet ripening process, using heat from water vapor (Mulyatiningsih, 2007).

Unripe Fe'i Banana can't be eaten, because it can cause itching in the throat. For that, usually the banana is processed before being eaten. Some way of processing is to be burned, steamed or made into cakes and chips (Samson *et al.*, 2013). Banana processing cane sky by fire is believed to refine the structure and improve the taste to be eaten. As well as by steaming, because it is not too eliminate the nutritional content of Fe'i Banana.

Some studies discuss the influence of the heating process of the carotenoid content of foodstuffs. Samson research results, Samson *et al.* (2013) revealed that the duration of heating affect the stability of the carotenoid pigment of Fe'i Banana. There was an 18% carotenoid degradation while heating the banana sticks between 5 and 10 minutes. Effect of steaming food was also put forward by Bengtsson *et al.* in Fungo and Pillay (2011), where "pengukusan" can markedly decrease the nutrient content of food, the amount of which depends on the type of food by steaming and steamed. The results of the study showed that sweet potato boiling over 20 minute result loss of β -carotene 9 to 16%. In the steaming process, before the carotenoids migrate into water as released from the carotene protein binding it, or the β -carotene protein complex is slightly soluble in water (Howard *et al.*, 1999).

On the other hand, according to Palupi *et al.* (2007), generally warming will increase the digestibility of foodstuffs that increase the benefits of the nutrients contained therein. Acyl studies show that pe cooking methods can increase carotenoid content, as it has been reported that maturation can increase carotenoids bioavailability in carrots, spinach and tomatoes (Stahl and Sie,; Stone *et al.* in Junpatiw *et al.*, 2013). The influence of ripening in bananas also revealed by a study conducted Engelberger *et al.* in Fungo & Pillay (2011) which showed that carotenoid content was higher found in banana samples cooked in raw banana samples.

Based on the observation, the ripening process length taken by the community on the banana of sky stick is not known for certain. Understanding that developed so far is the Fe'i Banana burned until the fruit rupture, then it is considered to have matured. In the initial test done, banana sticks to the sky burned his skin broke out are at about 10 minutes, but unknown β -carotene content in it in less than 10 minutes, at 10 minutes, and more than 10 minutes. Therefore, it is necessary to study the effect of ripening method (steam and burn) and ripening length in relation to β -carotene content.

Materials and Methods

The design of this study used a randomized, fully randomized experimental laboratory design method with a sample of 21 treatment groups and three repetitions. Analysis of β -carotene, proximate, and mineral contents was performed on unsweetened skeletons of celestial sticks, burnt banana sticks, and steamed Fe'i Banana. Unbleached skeletons of Fe'i

Bananas served as controls, while bananas burned sky sticks and banana sticks of steamed skies with some ripening length as a treatment group.

This research conducted in the Organic Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, Pattimura University, in March and April 2015. The sample or object in this study is 21 Fe'i Banana obtained from Soya village, District Sirimau, Ambon. The average weight of a Fe'i Banana is 260 g, which will be taken from one bunch of Fe'i Banana.

A total of 21 Fe'i Bananas prepared by the provisions, Fe'i Banana (to 3 repetitions) did not do any treatment, while the other Fe'i Banana each ripening fuel treated and steamed with a variety of different length. Treatment with a different ripening method in question is as follows:

1. Fuel method: three ripes Fe'i Banana burned near the source of the fire until a different length each 5, 10, and 15 minutes. Each length treatment is measured using a thermometer temperature.
2. Steamed method: three Fe'i Banana has not skinned steamed steamed in a pot containing 1500 ml of water that has been boiling up each length 5, 10, and 15 minutes. Each length treatment is measured using a thermometer temperature.

Analysis of β -carotene using UV-Vis spectrophotometry

The experimental procedure is done adaptation of the working procedure for the analysis of β -carotene by Apriantono *in* Musfiroh *et al.* (2009) and modified according to research needs. Stages of experiments were carried out as follows:

- a) Preparation of Standard Curves β -carotene and Wavelength Measurement Maximum
 1. β -carotene pure weighed weighing 50 mg, dissolved up to the mark in a mixture of acetone, n-hexane in a 100 mL flask to obtain a concentration of 500 mg/L.
 2. Take 20 ml of a solution with a concentration of 500 mg/L, as much as 100 mL to obtain a concentration of 100 mg/L. Retrieved 5 mL of solution with concentration of 100 mg/L, diluted to 100 mL to obtain concentration 5 mg/L. Take another 10 mL of solution with concentration 5 mg/L, diluted to 50 mL to concentrate to 1 mg/L.
 3. Perform dilution standard solution with varying concentrations: 0.5, 1.0, 1.5, 2.0, 2.5 mg/L.
 4. Foreign M each standard solution concentration was measured with a visible spectrophotometer absorbance at maximum wavelength obtained. The maximum wavelength of β -carotene obtained is at 450 nm.
 5. Standard curve created by the relationship between the absorbance and the concentration of β -carotene.
- b) Determination of β -carotene content
 1. Samples of the untreated Fe'i Banana weighed 5 grams, then extracted with a solvent mixture of acetone mL 20, 30 mL of n-hexane, 0.1 g of magnesium carbonate and stirred for 120 minutes using a magnetic stirrer at room temperature and filtered.
 2. The residue was washed with 15 mL of acetone, then washed with 15 mL of n-hexane, then washed using 10 mL of distilled water.
 3. The crude extract which d i get accommodated (to be established in two phases: an organic phase and water phase).
 4. These two phases are separated using a separation funnel.
 5. Acetone and extract are separated. The aqueous phase is removed, while the organic phase is taken for further analysis.

6. The organic phase was transferred into a 100 mL flask, vacuum to remove residual solvent at 30 ° C in order to obtain extracts of yellow.
7. Column chromatography column is prepared with a length of 40 cm and a diameter of 2.5 cm by 20 cm high alumina adsorbents, The sodium sulfate layer is placed as high as 5 cm above the adsorbent layer.
8. The obtained pigment extract was introduced into the column slowly, eluting with 100 mL acetone hexane solvent, while keeping the top layer always filled with solvent
9. The β -carotene elution results were collected in a 100 mL erlenmeyer and measured volume of the extract produced.

Samples of burnt and steamed celestial of Fe'i Banana were also given the same treatment according to the β -carotene measurements on unsweetened skeletons of celestial sticks, each at 5, 10, and 15 minutes of bananas being burned and steamed. This treatment is also done with three repetitions. Sample on repetition 1, 2, and 3 in each treatment method of ripening and the ripening length is different measured absorbance using visible spectrophotometer at the wavelength of maximum for β -carotene is 450 nm, is used also blank (acetone: n-hexane 1: 9 v/v).

Determination of β -carotene content in the sample is based on a standard curve obtained by (y) as the absorbance and (x) as concentration. The absorbance obtained from the sample is fed into the equation in the calibration curve and is obtained:

$$y = ax + b$$

Calculation of β -carotene content in the samples using the formula:

C_{reg} = regression concentration (mg / L)

V = sample volume (L)

G = sample weight (Kg).

Results and Discussion

The content of β carotene in Fe'i Banana were measured on samples of fresh fruit as well with steamed ripening method and bake for 5, 10, and 15 minutes. The content of β carotene in bananas fresh sky stick used as a control or comparison with samples made treatment. The measurement results β carotene content in the Fe'i Banana in this study can be seen in Figure 1.

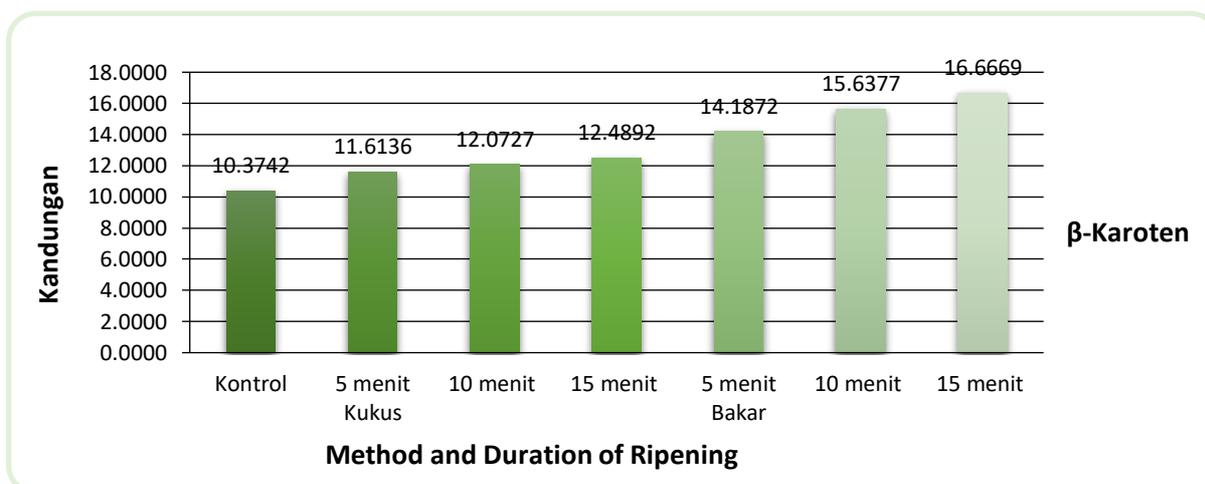


Figure 1. The content of β carotene Fe'i Banana

Figure 1 shows that the content of β carotene stick banana ripening sky treated steamed or grilled increased when compared to no treatment. Nevertheless, the content of β carotene with grilled ripening method is higher than the steamed method. Through this picture shows that the highest content of β carotene in the Fe'i Banana burnt sky for 15 minutes.

Effect of Ripening Methods Against The Content of β -Carotene in the Fe'i Banana (*Musa troglodytarum* L.)

Based on the results of the analysis of the first hypothesis testing variants in Table 1, it appears that in the control group and group ripening methods showed significant differences, where the p value of 0.000 ($p < 0, 05$). This means that there is a significant difference in the mean content of the β -carotene between the control, the ripening method of steam, and the fuel ripening method.

Table 1. Anova test results against effects of ripening methods the content of β -carotene Fe'i Banana

Ripening Method	Average \pm SD	F _{count}	Value-p
Control	10,3742 \pm 0,20818		
Steamed	12,0585 \pm 0.63363	124,792	0,000
Burn	15,4973 \pm 1.28132		

Duration of Ripening Against the Influence of β -Carotene Content

ANOVA statistical test result data for a long length of ripening can be presented in table 2. The results of the analysis in Table 2 show a significant difference, with p values of 0.002 ($p < 0, 05$). Through this result, it can be concluded that there are significant differences in the content of β -carotene control, with ripening length of 5 minutes, 10 minutes, and 15 minutes.

Table 2. ANOVA test results effect of duration ripening against β -carotene content of Fe'i Banana

Length of RipeningLength	Average \pm SD	F _{count}	Value-p
Control	10,3742 \pm 0,20818		
5 minutes	12,9004 \pm 1.55581	9,964	0.002
10 minutes	13,8552 \pm 2.04878		
15 minutes	14,5781 \pm 2,36521		

Ripening Methods Effective Against the Content of β Carotene

Based on analysis of the effect of ripening methods that show a significant difference ($p < 0, 05$), then, the analysis continued with Duncan's test. Duncan's test results further ripening methods influence on the content of β carotene Fe'i Banana can be seen in Table 3.

The result of hypothesis test analysis showed significant and very significant difference. Duncan test results in table 3 shows that the content of β -carotene control is significantly different from the ripening method and the difference is very evident with the fuel ripening method. While the content of β -carotene by ripening method is different from the real ripening method. If the comparison between the two controls with this ripening

method can be concluded that the ripening method that is effective against the content of β -carotene is a method of ripening fuel.

Table 3. The difference Duncan Test results against ripening methods the content of β carotene Fe'i Banana

Ripening Method	N	Subset		
		1	2	3
Control	3	10,3742		
Steamed	9		12,0585	
Burn	9			15,4973

The Effective Duration of Ripening Against The content of β carotene

Based on the analysis of long influence on the content of the ripening length β carotene, the results showed a significant difference ($p < 0.05$), so it can proceed with further test of Duncan. Duncan further test results are shown in Table 4.

Table 4. Duncan Test results differences in length of ripening against the content of β -carotene Fe'i Banana

Ripening Method	N	Subset		
		1	2	3
Control	3	10.3742		
5 minutes	6		12.9004	
10 minutes	6			13.8552
15 minutes	6			14.5781

The results of this hypothesis test analysis show significant and significant differences. Duncan test results in Table 4 show that the content of β -carotene is significantly different from the old control ripening length of 5 minutes and highly significant to the long ripening length 10 minutes and 15 minutes. While the content of β -carotene with a ripening length of 5 minutes is significantly different with the ripening length of 10 minutes and 15 minutes. Long ripening length 10 minutes is not significantly different from the long ripening length 15 minutes. Based on these results, it can be concluded that the length of length that is effective against β -carotene content is 10 minutes.

In this research, besides seeing the effect of method and ripening length, we also see the interaction between method and ripening length. The result of the interaction methods with long ripening length on the content of β carotene can be seen in Table 5.

Table 5. Results ANOVA Interaction Method and Length of Ripening Length Against Content of β -carotene Fe'i Banana

Source	The sum of squares	db	Average Squares	F	Sig. (P)
MP and WP	1.966	2	0.983	2,305	0.136

Description: MP = ripening method; WP = ripening duration

ANOVA test results in Table 5 indicate that the interaction between the old method of ripening the ripening length does not have significant differences, where the p-value of

0.136 ($p > 0, 05$). This means that there is no significant interaction effect of ripening method and ripening length to β -carotene content. Due to the lack of interaction, then it can't do a further test or Post Hoc.

Interaction Methods and Duration Ripening Against the Content of β Carotene

Besides seeing the effect of method and ripening length, this research also observed the interaction between method and ripening length. The result of the interaction methods with long ripening length on the content of β carotene can be seen in Table 6.

Table 6. Results of ANOVA interaction method and length of ripening length against gynecology β -carotene Fe'i Banana

Source	The sum of squares	db	Average Squares	F	Sig. (P)
RM and RD	1.966	2	0.983	2,305	0.136

Description: RM = ripening method; RD = ripening duration

Results of analysis of variance in Table 6 shows that the interaction between the old method of ripening the ripening length does not have a significant difference ($p > 0, 05$). This means that there is no significant interaction effect of ripening method and ripening length to β -carotene content. Due to the lack of interaction, then it can't be tested further.

Discussion

Effect of Ripening Methods Against The content of β -carotene in the Fe'i Banana (*Musa troglodytarum* L.)

The content of β -carotene in the Fe'i Banana controls according Image 1 of 10 3742 mg / kg increased after ripening. The content of β -carotene are needed in the body according to the National Health Interview Survey, the average intake for men of 2.9 mg / day, while for women the average adult 2.5 mg / day, and to reduce risk of chronic disease, required 3-6 mg/day. When compared with the results of the study, it can be concluded that in 1 piece of Fe'i Banana provides β -carotene needed for the availability of body nutrients. Ramadhani *et al.* (2012) describes the function of β -carotene that protects the eyes from cataract attacks. β -carotene and other carotenoids that are not converted into vitamin A, has antioxidant properties, so as to maintain the integrity of the body's cells.

Based on statistical analysis, a significant difference ($p < 0, 05$) average β -carotene content of the control with the treatment method of ripening. These results explain the benefits of food processing processes disclosed by Palupi *et al.* (2007) process that can be profitable by processing of some components of the nutrients contained in the food material, the change in the levels of nutrient content, improved digestibility and availability of nutrients and reduction of various compounds anti- -nutrition contained therein.

In this study, the results of a further Duncan test shows the difference between ripening method and the method of β -carotene content of fuel is higher. According Socaciu in Meiliana *et al.* (2014), processing food causes changes in food matrices that produce a negative influence (β -carotene damage due to isomerization and oxidation) or positive (increase the availability and bioavailability of β -carotene). Food processing process in this research yields positive influence with increasing of bioavailability of β -carotene.

The positive effects on ripening bananas fruits are also explained by studies conducted Engelberger *et al.* in Fungo & Pillay (2011) which shows that higher carotenoids content was

found in samples of the ripe bananas than the unripe bananas. Not only on Fe'i Banana, there is also a research revealed that ripening can improve bioavailability carotenoids in carrots, spinach and tomatoes (Stahl & Sie; Stone *et al.* in Junpatiw *et al.*, 2013).

Duration of Ripening Against the Influence of β -carotene content in the Fe'i Banana (*Musa troglodytarum* L.)

According to Begum in Rahayu & Pribadi (2012), although heating is the most important way to extend the shelf life of a material, but it can affect the degradation of the food substances contained in the material and this is highly dependent on the weight / duration of the heating process. The effect of heat on nutritional value is not only influenced by the temperature factor alone, but also influenced the duration of heating length. Actually there is no difference in the nutritional value of a material due to heating, as long as the heating is applied is not excessive and not too long.

Any processing method selected, retention carotenoids decreased with process length. Longer, temperature higher processing and the process of cutting or sublimate. Reduce ripening length, temperature, and lag length between peeling, cutting and smooth can improve retention significantly. High temperature / length processing which is short is a good alternative (Dutta, *et al.*, 2005). In line with the opinion of the Baloch *et al.* in Madalena *et al.* (2007) describes the longer warming length causing greater thermal isomerization so that the activity of vitamin A activity decreases. In contrast to the results of this study, where the higher temperatures due to increasing ripening length actually increasing the content of β -carotene. This is presumably because the Fe'i Banana burnt sky without any previous physical treatment such as stripping of the skin of the fruit, so the heat of the treatment methods of ripening (fire and water vapor) does not reduce the content of β -carotene in the fruit.

Ripening Methods Effective Against The content of β -carotene on Fe'i Banana (*Musa troglodytarum* L.)

Ripening is one of the simple and easy process of heat treatment. Ripening can be done with a medium of hot water called boiling or steam heat or so-called steaming. Steaming will also reduce nutrients but by less than the boiling process. Warming up with steaming is some lengths uneven because the ingredients on the edges usually undergo excess steaming, while in the middle it has less steam (Rahayu & Pribadi, 2012).

When compared with the control of bananas that are not given any treatment, steamed banana sky rods have a higher content of β -carotene. Thus, the steaming process is known to increase the content of β -carotene, but not as much as the β -carotene content by the fuel method. This is consistent with studies of Howard *et al.* (1999) explains that the steaming process, few carotenoids migrate to the water as released from protein carotene its binding, or protein complex β -carotene slightly soluble in water. Therefore the steaming process using steam, then when steaming β -carotene slightly soluble in water vapor so that its contents are not too large compared with the controls.

Further test results of Duncan β -carotene content for the treatment of ripening methods differ significantly with the controls, and differed significantly from the steam method. In simple terms can be explained that the content of β -carotene fuel control with different ripening methods is very significant, whereas the control with steamed ripening method is not too different significantly. In addition, the β -carotene content of the steam method by the fuel method did not differ significantly. This proves that the growing process

of ripening in the community about the banana of sky stick that is burned for consumption actually increases the content of β -carotene in it.

Actually, during the ripening length of 15 minutes there is also an increase in the amount of nutrient content, but statistically it is not significantly different with the ripening length of 10 minutes. Thus, the effective length of length taken is at 10 minutes. This is in accordance with the habits of people who cultivate bananas sky by burning sticks until his skin broke. In this study, the length duration of 10 minutes of banana skin stick sky began to break.

The Effective Duration of Ripening Against β -Carotene Content of Fe'i Banana (*Musa troglodytarum* L.)

In the long ripening length 10 minutes, with decreasing water content, the heat treatment with a long long length increase the content of β carotene Fe'i Banana. Actually, during the ripening length of 15 minutes there is also an increase in the amount of nutrient content, but statistically it is not significantly different with the ripening length of 10 minutes. Thus, the effective length of length taken was at 10 minutes. This is in accordance with the habits of people who cultivate bananas sky by burning sticks until his skin broke. In this study, the length duration of 10 minutes of banana skin stick sky began to break.

Mulyatiningsih (2007) explains that ripening with high temperatures can cause liquids that are in the food not much is lost. The fluid inside is retained by the hardened and caramelized food layer. As with the results of this study, the high temperature is proportional to the length of ripening length. This causes the longer ripening length and the higher the temperature, then the nutrient content in the Fe'i Banana is not lost.

Conclusions

Old ripening method and ripening length are statistically each showed significant differences ($p < 0,05$) on the content of β -carotene. Grilled ripening method and the duration of 10 minutes is more effective against β -carotene content of Fe'i Banana.

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