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Determination of Optimal Frying Time Based on Physicochemical and Organoleptic Tests on Banana Cracks

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KEYWORDS

Frying Time, Vacuum Frying, Banana Crackers.

ABSTRACT

The high production of bananas, especially kirana mas bananas, in Trenggalek Regency, East Java, has encouraged the local Agriculture and Food Service to foster several micro-enterprises (MSMEs) to produce banana crackers. The banana crackers produced by TSTP MSMEs are less attractive in color so they are less popular even though they have a good taste. This study aims to determine the optimal frying time in the MSMEs. There are 5 frying times tested, namely 50, 60, 70, 80 and 90 minutes. The results showed that the lowest fat content was produced at a frying time of 70 minutes, while water content, crispiness and ash content were not affected by frying time. The highest banana crackers color was at a frying time of 50 minutes, taste at a frying time of 70 minutes, aroma at a frying time of 50 minutes and texture at a frying time of 60-70 minutes. The optimal frying time was determined by the de Garmo test and the selected frying time was 70 minutes.

1. INTRODUCTION

In 2022, East Java province is the largest producer of bananas in Indonesia, namely 2.6 million tons or 28.35% of national production (Annur, 2022). One of the banana-producing areas in East Java is Trenggalek Regency. In 2022, banana production in Trenggalek Regency experienced a decrease in production by almost 50% compared to 2019 (BPS Trenggalek Regency, 2022). This is because bananas are classified as climatic fruits, which are fruits that quickly undergo damage or decay due to an increase in the high respiratory rate before cooking (Dufy, 2022) so that many farmers in Trenggalek Regency are reluctant to plant bananas. One of the efforts of the Trenggalek Regency Government in encouraging the intensification of banana cultivation is to introduce processed banana rambak, which is frozen bananas that are fried in a vacuum frying machine at a certain temperature and pressure so as to produce crispy snack products (Mahendra et al., 2021), to the community.

One of the micro businesses fostered by the Trenggalek Regency Agriculture and Food Office is the TSTP MSMEs. The characteristic of this banana rambak prouksi MSME is banana rambak from bananas mas kirana and banana kawak and has been marketed in cafes in the vicinity. This banana rambak is quite in demand and is often a souvenir from the Trenggalek Regency Regional Government, unfortunately the banana rambak produced in dark orange color is less attractive when compared to similar products that are golden brown (Figure 1).

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Figure 1. Rambak Banana (source a : Julianto (2023) ; b : @carara_surabaya)

Banana mas kirana has a lower sugar content than plantain and banana kepok, which is 12.36% (Fatsecret.co.id, 2020) while plantain and banana kepok are 19.22% (Fatsecret.co.id, 2022a) and 13.29% (Fatsecret.co.id, 2022b), respectively, but have a higher protein content than plantain and kapok banana (Table 1.). The high protein content in bananas will accelerate the caramelization process of banana rambak. This is because the frying time carried out by TSTP MSMEs is longer, namely 90 minutes, compared to some previous research results (Afrozi, 2018; Rahmanto & Daniyati, 2017; Tumbel & Manurung, 2017). Based on these problems, it is necessary to conduct research on the optimal time in the banana frying process with the vacuum frying method in order to produce color, taste, and crispiness that consumers like without ruling out the quality of the product produced.

Table 1. Nutritional Comparison of Bananas per 100 grams

Nutritional Content	Banana Mas*	Banana Kepok**	Plantain
Energy (kcal)	390	104	112
Fat (g)	0.330	0.260	0.340
Saturated Fat (g)	0.113	0.095	0.110
Polysaturated Fat (g)	0.072	0.055	0.084
Monosaturated Fat (g)	0.032	0.024	0.032
Cholesterol (mg)	0.000	0.000	0.000
Protein (g)	1.100	0.970	0.970
Carbohydrates (g)	23.270	24.440	30.730
Fiber (g)	2.600	2.500	2.300
Sugars (g)	12.360	13.290	19.220
Sodium (mg)	1	3	89
Kalium (mg)	365	420	319

2. METHOD

The manufacture of banana rambak was carried out at TPSP MSMEs located in Trenggalek Regency and the physicochemical properties test was carried out at the Agroindustry Laboratory, Faculty of Vocational Sciences, University of August 17, 1945, Surabaya in June 2023. Physicochemical and organoleptic observations were observed at 50, 60, 70, 80 and 90 minutes on a vacuum frying machine with a pressure of 70 cmHg at a temperature of 800C. The flow diagram of making banana rambak is presented in Figure 2.

The observation variables consisted of physicochemical properties including crispiness (texture, penetrometer method), moisture content (OAOC, 2005), fat content (Soxhlet method – semi-automatic), total ash content (muffle furnace 600-1000C method) and moisture content (gravimetric method) as well as organoleptic tests. The organoleptic test was carried out on 30 untrained panelists where each panelist assessed 3 (three) banana rambak for each treatment. Variety analysis (RAL) and BNT at a 95% confidence level were carried out on the physicochemical properties test data of banana

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rambak. The sensory test data was transformed by the MSI method before the variance analysis was carried out. The recommended treatment is carried out through the determination of the effectiveness value (Sullivan & Canada, 1984).

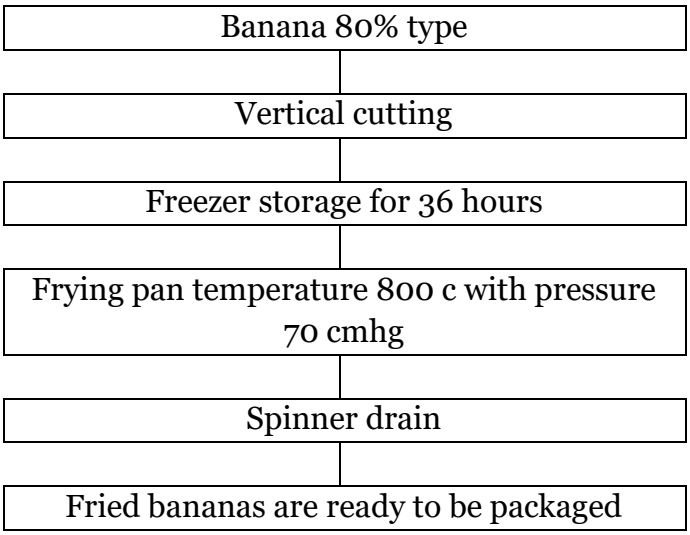

Figure 2. Flow Chart for Making Banana Rambak

3. RESULT AND DISCUSSION

Physicochemical Tests

The physicochemical tests observed include crispness, moisture content, fat content and ash content. The results of laboratory analysis showed that the frying time of banana rambak did not affect the crispiness, moisture content or total ash content of banana rambak. Only the fat content of banana rambak is affected by the frying time (table 2.).

The crispiness of the banana rambak is determined by the penetrometer method, where the higher the pressure resistance on the product, the deeper the penetrometer needle penetrates the banana ram, resulting in a higher hardness level value (the harder the product). The results showed that the crispiness level of the kirana mas banana rambak was not affected by the frying time, even though frying for 70 minutes produced the crispiest banana rambak where the average crispiness level of banana rambak was 39.07 mm/100gr/10sec (Table 2.). Similar research results were also obtained by Ayustaningwarno et al. (2020). Patra et al. (2022) said that crispiness is greatly influenced by the presence of water, fat, the amount of structural carbohydrates, hydrocolloids, and proteins in food products. In a vacuum fryer, the surface of the banana is in direct contact with the high-temperature oil and the center is in contact with the lower-temperature oil. This results in the outside of the banana rambak being crisper than the middle, resulting in a crispy product (Ayustaningwarno et al., 2020; Patra et al., 2022).

The results of the study showed a decrease in the moisture content of banana rambak with the longer frying time. This is in line with the results of Asrina, Jamaluddin & Fadillah (2021) research on salak chips. In the study, it was found that the reduction in moisture content was more than 50% if the frying time was increased from 30 minutes to 60 minutes (Muhammadali et al., 2021). The decrease in moisture content with longer frying time is influenced by heat transfer from cooking oil and product moisture loss (Dehghannya & Ngadi, 2021). In vacuum fryers, high pressure and low temperatures result in dilation of the pores of fresh ingredients. When water evaporates from fresh ingredients, cooking oil enters the ingredients, increasing the fat content in the food. The longer fresh bananas are soaked in cooking oil, the greater the potential for cooking oil to seep into the bananas (Castillo et al., 2021). After the process of frying banana rambak is completed (cooling process), air diffusion is faster than water and blocks the entry of cooking oil into the pores of banana rambak (Dueik et al., 2010). In Table 2, it appears that the fat content of banana rambak

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fried for 80-90 minutes increased compared to the observation of 50-70 minutes. The longer the frying process, the fatty acids produced from the oxidation of the oil will increase so that the fat content of the banana rambak increases. The opposite situation occurs in the moisture content, where the longer the fresh bananas are fried in a vacuum machine, the lower the moisture content.

Table 2. Physicochemical Properties of Banana Rambak at Various Frying Times

Frying Time (minutes)	Average Crispiness (mm/100g/10 sec)	Average Moisture Content (%)	Average Fat Content (%)	Average Ash Content (%)
50	38.67	4,379	2,385 c	4,430
60	40.11	4,541	2,082 a	4,217
70	38.00	4,667	1,983 a	3,403
80	40.56	3,805	2,059 a	3,754
90	38.00	3,421	2,165 b	4,201
BNT	tn	tn		tn

In the variables of crispiness, fat content and ash content, the increase in frying time up to 70 minutes decreases and gradually increases as the vacuum frying time is increased. This situation is in line with the results of a study by Ayustaningwarno et al, (2020) on vacuum frying of underripe mangoes where the fat content shows a sigmoid trend. Considering that in this study, the mas kirana banana was used in a condition of 80% ripeness.

Sensory Test

The sensory evaluation of banana rambak showed significant differences in all variables, namely color, taste, aroma and texture. One of the important product quality variables for vacuum-fried fruit is color. In vacuum conditions, the availability of oxygen is very low which slows down the rate of oxidation which can result in darkening of the color of the fruit. Low temperatures in vacuum frying will also inhibit non-enzymatic browning (Ayustaningwarno et al., 2018). The results of sensory analysis in Table 3 show a decrease in the level of preference for the color of banana rambak, where the longer the frying time occurs, the decrease in the level of preference. The longer frying time causes bananas to experience a maillard reaction considering that mas kirana fruit has a higher protein content than kepok and king banana types (Table 1.). The maillard reaction also results in changes in taste and aroma (Ayustaningwarno et al., 2018). The highest level of flavor preference is achieved at the 70-minute frying time. The maillard reaction causes a more legit taste in the banana rambak, but it removes the aroma of the banana so that there is a decrease in the level of liking with the longer the frying time.

Table 3. Sensory Test of Banana Sauce at 3 Different Frying Times

Frying Time (minutes)	Color	Taste	Aroma	Texture
50	5,23 c	3,26 a	5,50 c	4,61 a
60	4,56 b	4,87 c	5,49 c	5,43 b

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70	4,19 ab	5,15 c	4,73 b	4,93 ab
80	3,89 a	4,41 b	4,73 b	4,83 a
90	3,83 a	3,53 a	4,23 a	4,50 a

The loss of aroma in banana rambak is due to the aroma of fruit coming from volatile compounds present in the fruit (Aziz et al., 2019). Esters, alcohols, fats, and short-chain fatty acid compounds contribute to the distinctive aroma in immature bananas compared to ripe bananas (Ridhyanty et al., 2019; Suryanti et al., 2017). During the heating process, the volatile components of the fruit will decrease in rate, resulting in a decrease in the specific aroma of the fruit. Xi Chen et al. (2023) stated that there are 3 (three) levels that have significantly different levels before and after vacuum frying, namely 2,3-pentanedion, hexanal, and pentanal (Chen et al., 2023). The decrease in volatile compounds results in the loss of the specific taste and aroma of fruits fried in a vacuum fryer (Muhammadali et al., 2021; Sihombing et al., 2018). The reduction of volatile compounds does not require high temperatures, pasteurization of the juice for 30 minutes at a maximum temperature of 800C has lowered antioxidant activity by almost 50% and lowered the level of preference of the panelists (Ameliah et al., 2023; Ningtiyas, 2022).

Food texture is a combination of perception through sight, touch and oral processing. The results of the study showed that the highest level of preference of the panelists was the treatment of 60-minute frying time followed by 70-minute frying time. At the beginning of vacuum frying, there is rapid shrinkage of food products due to pressure in the pores of food ingredients so that water migration occurs to the surface of the ingredients. As a result, the parts that directly come into contact with cooking oil undergo faster hardening (case hardening) thus preventing further shrinkage of the product. The next process, the closure of the pores of the food due to the hardening case results in the accumulation of gas pressure in the microstructure of the food so that the development of the material in the axial direction occurs. The increase in porosity and porosity of the final product produced by the development process is directly related to the crispiness and acceptance of snacks (Yamsaengsung et al., 2011). The longer the frying time, the drier the center of the banana rambak will be lowered, lowering the level of liking for the texture of the banana rambak.

Optimal Frying Time

The determination of the effectiveness value is carried out to determine the optimal frying time. In the physicochemical test, the frying time of nutrients had a significant effect on the fat content where the fat content of the frying time of 60-80 minutes was not different, while the moisture content, crispiness level and ash content were not affected by the frying time. All sensory test variables were affected by frying time, where the level of preference for color at 50-minute frying time, taste and texture at frying time 60-70 minutes, aroma at frying time 50-60 minutes.

The main problem of this study is the color of banana rambak produced by TSTP MSMEs which is dark in color even though it is quite preferred by consumers. Based on this, the color of the product is given the highest weight in determining the effectiveness value. The weight determination of each variable is then based on a survey of several panelists. In the Sensory Test, the highest productivity value was obtained at 60

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minutes of frying time, while in the physicochemical test the highest value was obtained at 90 minutes of frying time. The optimal frying time is the highest effectiveness value obtained from the sum of the productivity values of each frying time. In Table 3, it appears that the highest effectiveness value was obtained at the frying time of 70 minutes and was determined as the optimal frying time of banana rambak in TSTP MSMEs. The time required to fry banana rambak is longer when compared to Afrozi, Mufarida & Sofiyah (2018) research on kapok banana chips, which only takes 50 minutes. This difference is due to the difference in dimensions of banana chips and banana rambak. Banana chips are thin slices of bananas horizontally, while rambak banana is a whole banana that is fried in hot oil in a vacuum. Vacuum frying whole bananas produces products with low fat content and lighter colors than atmospheric frying, but results in greater shrinkage, less crispiness and a harder texture (Udomkun et al., 2018).

Table 3. The Value of the Effectiveness of Banana Rambak at Various Frying Times

Productivity Value	Frying Time (minutes)				
	50	60	70	80	90
Sensory Test	0,399	**0,529**	0,405	0,247	0,014
Physicochemical Tests	0,055	0,044	0,226	0,121	**0,241**
TOTAL	0,454	0,572	**0,631**	0,367	0,255

4. CONCLUSION

Color and texture are important variables of fried food because they are directly related to consumer acceptance. Changes in the physical and chemical properties of banana rambak are the cause of changes in color and texture. Setting the optimal frying time is expected to reduce the production cost of banana rambak in addition to producing more attractive colors and crispier textures.

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