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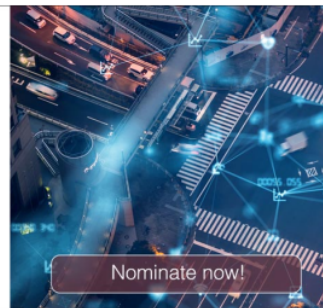


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Physicochemical characterization of peel, flesh and banana fruit cv. raja (*Musa paradisiaca*)

L Syukriani¹, S Febjislami², D S Lubis², R Hidayati³, A Asben⁴, I Suliansyah², J Jamsari^{2*}

¹Student of Doctoral Program, Faculty of Agriculture, Andalas University, Padang, West Sumatera, Indonesia

²Department of Agrotechnology, Faculty of Agriculture, Andalas University, Padang, West Sumatera, Indonesia

³Department of Biotechnology, Graduate Program, Andalas University, Padang, West Sumatera, Indonesia

⁴Department of Agricultural Product Technology, Faculty of Agricultural Technology, Andalas University, Padang, West Sumatera, Indonesia

E-mail: ajamsari@agr.unand.ac.id

Abstract. All parts of a banana cv. Raja can be used as functional food and health or beauty products. The physicochemical properties of fruit peels, pulp and banana cv Raja need to be known to determine the type of processing because it can affect the final product processed. This research aimed were to determine the characteristics of banana cv. Raja Flour from peel, flesh and fruit and its minerals content. The results obtained from the analysis of moisture content ranged from 6.21 to 39.33%, ash content was 1.33-1.86%, protein content was 2%. The content of vitamin C in the peel, fruit and flesh of bananas is 32.3 mg/100 g, 7.18 mg/100g and 4.99 mg/ 100g respectively. The mineral content of potassium (K) and calcium (Ca), in banana peels, is higher than the flesh and fruit of bananas, such as 73.03% and 16.12%, while the content of phosphorus (P), magnesium (Mg) and chlorine (Cl) in The pulp was higher than the skin and banana fruit 10.52%, 6.58%, and 4.37% respectively. The crystalline structure of banana flour from banana peels, fruit flesh and fruit shows the same type is type A and the gelatinization temperature ranges from 74.85 to 76.90C within 8.6 to 10.6 minutes.

Keywords: banana peel, flesh, vitamin C, XRF, XRD, RVA

1. Introduction

Banana is a leading fruit commodity in Indonesia, its production always increases every year and has bright prospects as an export commodity. available in the market and does not depend on the season. Banana fruit can be consumed in fresh form or processed first. Banana is a climacteric fruit that cannot be stored for long. Bananas can be processed into finished products (directly consumed) or semi-finished products (as raw material for processing other foods such as flour). Plantains have a fruit that curves slightly upwards, the skin is thick and slightly rough. When ripe these bananas are orange-yellow with a fragrant aroma. Currently, the use of bananas as a food product is not only for the pulp but also on the skin of the fruit. Banana peels make up approximately one-third of the total banana weight. Banana peels are high in fiber, phenolic and pectin.



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All parts of the banana can be processed into flour including banana peels [1]. Consumption of green bananas (peel and pulp) is beneficial for human health because of the high content of resistant starch which plays a role in the body as dietary fiber [2, 3], as a source of polyphenols, protein, essential amino acids, polyunsaturated fatty acids and potassium [4], as well as natural antioxidants, carotenoids, and other bioactive compounds that have various beneficial effects on human health [5-7].

Banana cv Raja has the highest vitamin A content compared to other bananas, characterized by their reddish-yellow flesh colour [9]. The shape of the fruit curves slightly upwards, the skin is thick and a little rough. When ripe, the banana peel is orange-yellow with a fragrant aroma. Currently, the use of Raja banana as a food product is not only for the flesh but also on the skin of the fruit. Banana peels make up approximately one-third of the total banana weight. The objective of the research was to determine the physicochemical characteristic and the nutritional composition of peel, pulp and fruit of banana cv. Raja.

2. Materials and Methods

2.1. Material

The materials used in this study were banana peel, pulp and plantain fruit at maturity level 1. Samples were taken from farmers' gardens in Kampung Pisang Kec. IV Koto, Kab. Agam, West Sumatra.

2.2. Sample preparation

Bananas are washed with water, then peeled and dried in an oven at 50°C overnight. Meanwhile, the pulp is cut into 1-2 mm sizes then soaked in a 5% solution of citric acid, for 10 minutes, then dried in an oven at 50°C overnight. Making flour from bananas is the same as making flour from the pulp, it's just that the fruit skin is not peeled off. The fruit is cut into 1-2 mm sizes, then soaked in a 5% citric acid solution, for 10 minutes, then dried in an oven at 50°C overnight. Fruit and fruit skin that has been dried is mashed using a blender then sieved using a sieve with a mesh size of 250 μm .

2.3. Determination of parameters

Determination of proximate analysis (moisture, fat, ash and protein) were made using the methods from AOAC (2005). analysis of vitamin C content using the iodine titration method. Mineral content was carried out using EPSILON-3 (PANalytical, Netherlands) X-Ray Fluorescence Spectrometer. The crystalline structure of banana starch was studied using X-ray diffractometer (Xpert Powder PANalytical PW 30/40, Netherlands). The X-ray diffraction system was operated at 40 kV and 30 mA and the starch diffractogram was recorded from $5^{\circ}2\theta$ to $50^{\circ}2\theta$ with a scanning speed of $0.002^{\circ}/\text{sec}$ and a scanning step of 0.02° . Relative crystallinity was calculated by the ratio of the crystal area to the total diffraction area. Starch viscosity was evaluated using Rapid Visco Analyzer (RVA-Techmaster, 2009, Newport Scientific Pty. Ltd, Australia) and the calculation was performed using Thermocline for Windows v3.0 (TCW3).

3. Results and Discussion

3.1. Proximate Analysis of Plantain Skin, Flesh and Fruit Flour

Proximate analysis is a chemical analysis method to identify the nutrient content of an ingredient. The purpose of the analysis is to determine quantitatively the main components of a food ingredient. The results of the proximate analysis of skin flour, fruit flesh and bananas can be seen in Table 1.

The water content of banana peel flour is higher than banana fruit and flesh, this is thought to be due to the high tannin content in banana peels. When dried banana peels still feel sticky gummy, as well as when mashed. The moisture content obtained in peel, flesh and fruit of plantain includes water content of type B. According to SNI No 01-3841-1995 regarding flour, the maximum water content is 12% in banana flour including type B banana flour. The fat content in banana peel flour is higher than

fruit flour and fruit flesh was 5.54%, while the lowest was found in fruit flesh flour was 0.18%. The ash content in the pulp was 0.8% higher than the banana peel and flour. Ash content is a calculation of the remaining inorganic material from the ashing process. The ash content can affect the colour and texture of the starch. The protein content in banana peel and flesh was almost the same, ranging from 1.81-1.86%. The protein content obtained in this study was still low according to SNI standards, was 7%. However, the nutritional composition of the skin, pulp and plantain fruit shows a good source of nutrition [8]

Table 1. Proximate analysis of banana flour from banana peels, fruit flesh, and banana fruit

Part of fruit	Moisture (%)	Fat (%)	Ash (%)	Protein (%)
Peel	9,33±0,43	5,54±0,30	1,86±0,26	2,10±0,18
Flesh	6,21±0,58	0,18±0,13	1,81±0,55	2,03±0,09
Fruit	6,48±1,07	2,07±0,19	1,33±0,30	2,04±0,10

3.2. Analysis of Vitamin C Content

Vitamin C or ascorbic acid is a vitamin that has many benefits, including skin health, disease prevention, and cancer cells. The vitamin C content in banana peel flour is 32.3 mg / 100g, while the vitamin C content in the fruit and pulp is 7.18 mg / 100g and 4.97 mg/100g, respectively. Research conducted by Wekti and Khaerunnisa [10] obtained vitamin C content in cv bananas is 7.6 mg/100g. Then the research of Pratiwi et al [11] on plantain peels using the UV-Visible spectrophotometric method found that the vitamin C content of banana cv. Raja peels were 0.0253 mg/ml higher than the vitamin C content in banana cv. barangan, banten and lilin respectively 0, 0.0219 mg/ml, 0.0173 mg/ml, 0.0172 mg/ml.

3.3. XRF

The mineral content of banana peel flour, fruit pulp and banana fruit cv. Raja analysis using the X-Ray Fluorescence (XRF) method can be seen in Table 2. The XRF method has several advantages including the sample required is relatively small (about 1 gram), the sample analysis is not required standards, has high accuracy and precision, and can determine almost all mineral content in biological materials which can be immediately known the results [12].

Minerals are essential elements for optimal body metabolic function. Minerals have a function to help the body produce enzymes and hormones and maintain healthy bones, muscles, heart and brain to function normally. Minerals are divided into 2 types, namely macro and microminerals. Macrominerals are minerals that the body needs in an amount more than 100 mg a day, including calcium, magnesium, phosphorus, potassium, sodium, chloride, and sulfur. Meanwhile, the microminerals needed less than 100 mg a day include iron, zinc, iodine, copper, fluoride, selenium, sodium, manganese, and so on.

Minerals have an important role in maintaining the body, both at the level of cells, tissues, organs, and body functions as a whole. Minerals also play a role in various stages of metabolism, especially as a cofactor in enzyme activity. The content of macro minerals such as potassium found in banana cv. Raja peel flour was higher than banana flesh and fruit by 73.024%. The phosphate content in the skin of the fruit is lower than flesh and fruit, which is 2.936%. While the sulfur content is only found in the skin of the fruit, while the chlorine content is not found in banana peels. Research conducted by Moza et al [13] showed that the mineral content of K, Ca, Na, and Mg in a fresh banana peel was higher than dry banana peels. The mineral content of K, Ca, Na, and Mg in fresh banana peels (Musa acuminata) were 78.10 mg / 100g, 19.20 mg / 100g, 24.30 mg / 100g, and 76.20 mg / 100g, respectively. While the mineral content of K, Ca, Na, and Mg in dry banana peels each were 62.81 mg / 100g, 16.75 mg / 100g, 22.34 mg / 100g and 65.14 mg / 100g. The mineral content of Fe (0.61 mg / 100g) on fresh bananas was lower than dried banana was 0.15 mg / 100g.

Table 2. The mineral composition of banana flour cv. Raja from banana peels, fruit flesh, and banana fruit

Mineral Composition	Concentration (%)		
	Peel	Flesh	Fruit
<u>Macro Minerals</u>			
Potassium (K)	73,024	60,028	69,858
Phosphorus (P)	2,936	10,516	5,331
Sulfur (S)	1,865	-	-
Calcium (Ca)	16,122	10,897	14,654
Magnesium (Mg)	0,434	6,58	2,076
Chloride (Cl)	2,181	4,371	3,215
<u>Micro Minerals</u>			
Silver (Ag)	1,505	2,193	1,71
Silicon (Si)	0,764	3,035	1,42
Iron (Fe)	0,159	0,482	0,262
Rubidium (Rb)	0,413	0,755	0,615
Manganese (Mn)	0,342	0,66	0,516
Zinc (Zn)	0,154	0,23	0,168
Europium (Eu)	0	0	0
Rhenium (Re)	0,001	0,005	0,013
Brom (Br)	0,057	0,092	0,083
Itrium (Y)	0,005	0,027	0,007
Cuprum (Cu)	0,026	0,129	0,073
Cobalt (Co)	0,002	-	-
Nikel (Ni)	0,01	-	-
Selenium (Se)	0,001	-	-

This macromineral element functions to maintain fluid balance and distribution, maintain osmotic pressure balance, maintain muscle irritability, chlorine functions to maintain stomach acidity and helps digestion, potassium functions to activate enzymes for the formation of new proteins. The micromineral elements found in banana peels consist of 14 more elements than the flesh and fruit of banana cv. Raja, but with a lower concentration of macro mineral elements. This micromineral has a function to help the metabolic process of food substances.

3.4. Analysis of Crystallinity (XRD)

The crystallinity of the starch grains can be seen using the X-ray diffraction pattern method and can be determined by integrating the curve under the peaks of the amorphous and crystalline regions [14].

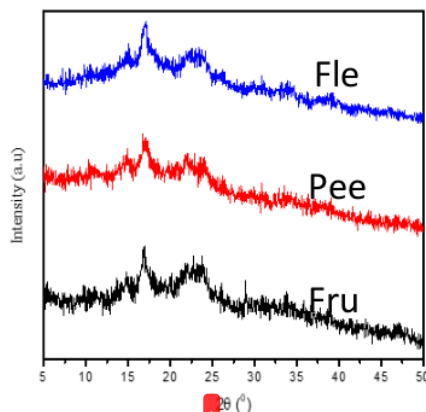


Figure 1. XRD graph of banana flour cv. Raja from banana peels, fruit flesh, and banana fruit

The X-ray diffraction pattern on the peel flour, pulp and banana fruit showed the same pattern, only the X-ray intensity (area or peak of amylograph) was different. According to Cai and Wei [15], there are several X-ray diffraction patterns from starch, namely the XRD type A pattern which has strong diffraction peaks around 15° and 23° , and imperfect peaks around 17° and 18° . Type B XRD patterns have the strongest diffraction peaks at around 17° , as well as several small peaks at around 15° , 20° , 22° , and 24° , and specific peaks at 5.6° . The type C XRD pattern has mixed properties of type A and type B. The typical type C XRD pattern has the strongest peaks around 17° and 23° , and several small peaks around 5.6° and 15° . Based on the diffraction pattern shown in Figure 4, it can be concluded that the X-ray diffraction pattern of skin flour, pulp and banana fruit is type B, because the strongest peaks occur at 17° and small peaks at 15° , 22° and 24° .

3.5. Gelatinization Profile Analysis (RVA)

The gelatinization profile data of banana starch processed from the RVA curve can be seen in Table 3. Fruit flour has the highest peak viscosity, which is 4448 cp compared to banana fruit and peel, 3786 cp and 1749 cp, respectively. For complete gelatinization, it is faster than fruit flour and pulp, which is 8.6 minutes. The gelatinized pulp of pulp at a lower temperature than other flour. The temperature of gelatinization in the pulp of fruit pulp was 74.85°C , while the gelatinization temperature of fruit and banana peels was 75.65°C and 76.9°C . According to Immaningsih [16], the temperature and time of gelatinization were influenced by the amylopectin structure, starch composition and granule architecture. The high setback viscosity value of the flour from the pulp and bananas indicates that the gel tends to harden at the end of the cooking process, so that the processed product is not easily destroyed [17]. The low viscosity value of breakdown and setback of banana peel flour indicates instability in the heating process. This product profile is not suitable for applications with high-temperature processing products [18].

Table 3. RVA analysis of banana flour cv. Raja from banana peels, fruit flesh, and banana fruit

Pasta characteristics	Peak (cP)	Trough (cP)	Breakdown (cP)	Final Viscosity (cP)	Setback (cP)	Peak Time (Min)	Pasting Temperature ($^\circ\text{C}$)
Peel	1749	1639	110	2612	973	10.6	76.9
Flesh	4448	2953	1495	4174	1221	8.6	74.85
Fruit	3786	3011	775	4503	1492	9	75.65

4. Conclusion

Banana peel flour has the potential to be developed as a health and beauty product because of its high vitamin C and mineral content such as facial masks, reducing facial oil, and accelerating the fading of scars, while fruit and banana flour can be applied as food processed products for making ice cream and yogurt.

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