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FOOD INNOVATION

FOR ASIAN COMMUNITY DEVELOPMENT

PROCEEDINGS OF THE 3rd INTERNATIONAL CONFERENCE ON SUSTAINABLE GLOBAL AGRICULTURE AND FOOD

09 - 10 November 2018, Ho Chi Minh City, Vietnam

SCIENCE AND TECHNICS PUBLISHING HOUSE

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PREFACE

The International Conference on Sustainable Global Agriculture and Food (ICSAF) is an important event organized every two years. The 3rd ICSAF was held in Ho Chi Minh City, Vietnam, under the auspices of Vietnam Association of Food Science and Technology (VAFOST). Saigon Technology University, Vietnam (STU) was Organizer, and Assumption University, Thailand (AU), Fu Jen Catholic University, Taiwan (FJCU), Soegijapranata Catholic University, Indonesia (SCU) were Co-Organizers of this conference. The theme was "**Food Innovation for Asian Community Development"**.

The purpose of the Conference was to highlight significant research and developments for sustainable global agriculture and food production with an emphasis on product innovation. The Conference also aimed to advance regional cooperation in order to promote and apply the research in food science and technology. Aside from food technology development and food innovation, the conference also discussed issues related to Nutrition, Sensory Science, Food Science, Food Engineering and Technology, Food Safety and Quality. This Proceedings will cover all of these discussions.

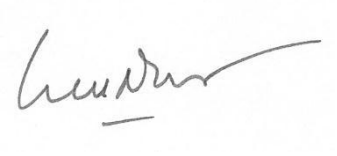
The Proceedings is divided into 4 sessions covering a wide range of topics of food science and technology. Furthermore, issues related to agriculture, biotechnology, and the environment are also addressed in line with the theme of the Conference.

The papers have been peer-reviewed and edited by an editorial board of the Organizing Committee to be as readable as possible.

The Organizing Committee wishes to thank all authors and delegates, and all who have contributed to the success of the Conference.

Assoc. Prof. Ngo Tien Hien
President of Vietnam Association of Food Science and Technology (VAFoST)

Assoc. Prof. Cao Hao Thi
Principle of Saigon Technology University (STU)



Prof. Dr. Luu Dzuan
Dean of Food Technology Faculty (STU)

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INDEX

SESSION 2

FOOD CHEMISTRY, MICROBIOLOGY, QUALITY AND SAFETY

SESSION 3

FOOD PROCESSING AND ENGINEERING

QUALITY CHARACTERISTICS OF BANANA FLOUR AND STEAMED CAKE PRODUCED FROM THREE BANANA VARIETIES

Rainier R. Zunggaval; Katharina Ardanareswari; *Probo Y. Nugrahedi

Department of Food Technology, Soegijapranata Catholic University, Jl. Pawiyatan Luhur IV/1, Semarang, 50234, Semarang, Indonesia

**Email: probo@unika.ac.id*

ABSTRACT

Processing banana into flour is a way to increase its shelf life and functionality. In food industry, banana flour can be used as wheat flour substitute. In this study, banana flour and, subsequently, the banana steamed cake, were produced from three local banana varieties namely *ambon*, *kepok*, and *nangka*. Physicochemical quality attributes measured on the flour included moisture content, yield, color, water holding capacity, starch, amylose, amylopectin, fiber, and potassium content. The measurement on quality attributes of the steamed cake was texture (hardness and ease of swallowing), color, volume expansion, and potassium content. Hedonic sensory analysis was also performed for the cake. Results showed that different banana varieties gave significant differences in some parameters of the flour namely moisture, yield, color and starch content. When compared to wheat flour, banana flour had higher starch, potassium, and fiber content. Meanwhile, steamed cake quality attributes showed significant differences compared to wheat flour in terms of color, texture, and volume expansion. Hedonic test result showed that wheat flour steamed cake had the highest score but did not differ significantly from the *ambon* banana steamed cake.

Keywords: banana, flour, steamed-cake, variety, quality

1 INTRODUCTION

Banana is one of the most widely found and consumed tropical fruits in Indonesia. Banana production in Indonesia is the highest compared to other fruits such as mangoes and oranges, at up to 6.8 million tons in 2014 [1]. However, postharvest loss of banana is considered high. Therefore, there is a need to increase the shelf life as well as the commercial value of banana. One option is by converting the fruit into flour. Banana flour has low water content and water activity; hence, it will increase the shelf life [2]. Processing banana into flour also gives other benefits, such as its flexibility to be fortified with other nutrients as well as to be main ingredient of final food products [3]. Flour also make banana easier to be handled along the chains of packaging, distribution, and storage [4].

Banana flour was made from unripe banana (yellowish-green color) because ripened banana will disrupt the drying process due to its sugar content that can trigger caramelisation and contributes to the unexpected color, aroma and taste. Nevertheless, banana flour has high nutritional content. In food industries, banana flour is often used to make weaning food and bakery products [4]. Starch content in banana flour contributes to the food texture characteristics.

Many varieties of banana can be processed into flour. It was hypothesized that different banana varieties will affect to different flour characteristics. Studies by Elvis [5] and Abbas *et al* [6] reported that different banana varieties resulted in significant differences of water holding capacity, yield, and color of the flour. These can be due to the differences in physical shape, water content, and starch content of the banana [5].

Moreover, application of banana flour into food production was also reported to have different characteristics than employing wheat flour. Silfia [7] investigated brownies production applying banana or wheat flour and observed that brownies of banana flour had lower water and protein content compared to wheat flour brownies. Sensorially, taste, texture, and aroma of banana flour brownies was more preferred than wheat flour brownies. Our study applies banana flour to produce steamed cake to be compared with cake made from wheat flour.

2 MATERIALS AND METHODS

2.1 Banana flour production

Three local unripe (yellowish green) banana varieties namely *ambon*, *kepok*, and *nangka* were obtained from Gunungpati traditional market in Semarang. Each banana was peeled and sliced using *robot-coupe CL* 50 slicer. Then, the slices were soaked in 0.2% NaS_2O_5 solution (w/v) for 15 min. Drying was performed by a cabinet dryer at 60^oC for 8 h. Dried banana slices were grinded (*Philips dry-mill blender*) and sieved at 80 mesh.

2.2 Steamed cake production

Steamed cake was made by firstly mixing the dry ingredients such as flour, milk powder, and baking powder. In a different mixing bowl, eggs, sugar and emulsifier were mixed for three min. The dry mixture was added with the batter and mixed. Subsequently, melted margarine was added to the batter and mixed evenly, followed by pouring into baking tray and steaming for 25 min.

2.3 Physicochemical analysis

Analyses of water content, color, and water activity were performed by using moisture balance (*Ohaus MB*45), chromameter (Minolta CR-400), and Aw meter, subsequently. Amylose content and starch content were measured by spectrophotometry method. Water holding capacity (WHC)

was measured by centrifugation method. Crude fiber content was analysed by thermogravimetric method after extraction with 0.25 N H_2SO_4 and 0.25 N NaOH solutions. Potassium content was analysed by atomic absorption spectroscopy. Texture (hardness) was measured by a texture analyzer (*Lloyd instrument TA plus*), and volume expansion was measured by seed displacement method.

2.4 Hedonic test

Sensory analysis was performed by a rating hedonic test at a five-scale, by 40 SCU Food Technology Department students. Some attributes were evaluated, i.e. aroma, color, texture (in terms of hardness and ease of swallowing), taste, and overall perception.

2.5 Data analysis

Data obtained from the physicochemical measurements was analysed by one way ANOVA followed by Duncan test. Meanwhile, data of hedonic test was analysed by Kruskal Wallis followed by Mann Whitney test.

3 RESULTS AND DISCUSSION

3.1 Banana flour

Prior to drying, moisture content of *ambon* banana is the highest (66.29 ± 2.93%) and significantly different than *kepok* banana (57.76 ± 0.76%) and *nangka* banana (59.13 ± 0.89%). This study used mature but unripe banana, at yellowish green color of the peel. In general, ripe banana can have higher moisture content than the unripe one. Putri [8] reported that the moisture contents of *ambon*, *nangka*, and *kepok* bananas are 73.8%, 68%, and 62%, respectively. Low moisture content and high amount of starch of unripe banana can affect to the yield of flour [4]. This study found that *ambon* banana, which contains the highest moisture content, produced the lowest yield (25%) and the *nangka* banana produced the highest yield of flour (29%).

Quality attributes of banana flour can be seen at Table 1. Moisture content of the flour is below 10% and as expected, the highest is found at *ambon* banana flour. *Nangka* banana flour has the highest yield and significantly different as compared to the lowest one. Result on water holding capacity, water activity, fiber, and starch content show that there are no significant difference between banana varieties. Meanwhile, for potassium content, the *nangka* banana flour has the highest among others.

Table 1: Physicochemical quality attributes of banana flour

Parameter		Banana Variety			Ref.
		Kepok	*Ambon*	*Nangka*	(Wheat)
Water (%)		8.35 ± 1.23^{ab}	9.08 ± 1.13^{a}	7.90 ± 0.59^{b}	
Yield (%)		29.18 ± 1.42^{b}	25.71 ± 0.26^{a}	31.65 ± 2.49^{b}	
Color	L	88.95 ± 1.54^{a}	90.35 ± 0.41^{b}	86.74 ± 1.92^{c}	$95,54 \pm 0,24^{d}$
	a*	-0.90 ± 1.01^{bc}	-1.25 ± 0.55^{a}	-0.43 ± 0.75^{c}	$-0,85 \pm 0,07^{ab}$
	b*	17.98 ± 2.54^{b}	16.28 ± 1.31^{a}	16.14 ± 2.76^{a}	$9,48 \pm 0,11^{c}$
WHC (g H_2O/ g)	40°C	2.77 ± 0.28^{a}	3.03 ± 0.38^{a}	2.97 ± 0.41^{a}	$7,55 \pm 0,11^{b}$
	60°C	2.73 ± 0.24^{a}	2.83 ± 0.43^{a}	2.75 ± 0.20^{a}	$5,67 \pm 0,06^{b}$
Aw		0.46 ± 0.01^{a}	0.44 ± 0.04^{a}	0.45 ± 0.06^{a}	
Fiber (%)		11.6 ± 2.4^{a}	12.2 ± 2.6^{a}	11.4 ± 2.8^{a}	$5,3 \pm 1,2^{b}$
Starch (%)		65.71 ± 2.68^{a}	64.60 ± 2.66^{a}	67.21 ± 4.88^{a}	$58,92 \pm 0,81^{b}$
Amylose (%)		35.27 ± 1.20^{a}	36.22 ± 2.94^{a}	34.88 ± 0.90^{a}	$22,89 \pm 0,44^{b}$
Amylopectin (%)		64.73 ± 2.56^{ab}	63.78 ± 4.65^{a}	65.12 ± 5.16^{ab}	$77,11 \pm 0,91^{b}$
Potassium (mg/100g)		783 ± 114^{a}	967 ± 154^{b}	988 ± 193^{b}	

**) Mean ± SD of duplicate determinations (n=9). Values with different superscripts differ significantly ($p < 0.05$).*

Water holding capacity (WHC) is the interaction between components in flour such as protein and starch with water in food. Our study found that the WHC of banana flour is in the range of the WHC of flour needed in the manufacturing of viscous and chewy food products such as soups, sauces, and bakery products [9]. This indicates that banana flour has good WHC to be applied in bakery products. Different temperatures were used to measure WHC, which aimed to check the gelatinization ability of each flour [10]. All banana flour show no significant changes of WHC at 40°C and 60°C, but slightly decrease for the wheat flour at 60°C. This could be due to the heating process did not reach the gelatinization temperature of banana flour, which is 68.8-77.5°C, while the gelatinization temperature of wheat flour is 53-63°C [7]. Another possible explanation is due to different protein content. One of the factors affecting WHC is protein

because it can absorb and bind water, higher protein content will impact to higher binding water ability [11].

The low water activity of the flour (0.44-0.46) could prevent growth of microorganisms and reduce the rate of rancidity of flour [12]. Banana flour also contains higher fiber content than wheat flour. Referring that fiber requirement for adults per day is ± 30g, depending on total calorie intake [13], intake of 100 g of these banana flour can provide 30% of fiber. Moreover, potassium is one of the essential minerals to control total volume of body fluids, acids and electrolytes, as well as maintain cell function. Potassium contents in the banana flour are 0.783-0.988%. The daily nutritional intake recommended by WHO for potassium is 3510 mg/day for adults [14]. This indicates that 100 grams of banana flour can fulfilled 22-28% potassium needs per day.

3.2 Steamed cake

Quality attributes of steamed cake produced from banana flour and wheat flour are shown in Table 2. Wheat cake has the brightest appearance while *ambon* banana cake is the darkest. The wheat cake is also more yellow than others. Apparently, this is due to the color of the flour; whereas wheat flour is white and banana flour is light brown. All banana steamed cakes show no significant difference in volume expansion but the wheat cake is significantly the highest. This could be due the role of protein in wheat in entrapping gas formed during mixing and contribute to dough viscosity and extensibility [15].

In addition, hardness level of wheat cake is the highest. Texture level of the cake is correlated with the WHC of the flour, i.e. higher WHC is followed by harder texture. This is probably due to the smaller size of starch granule in wheat flour (2-35 μm) than banana flour (60-105 μm). Large starch granules can cause bonded water molecules to be easily released during heating or cooking process. The more water is released during heating, the softened the product could be obtained [7].

Table 2: Physicochemical quality attributes of steamed cake

Parameter		Type of Flour*			
		Kepok	*Ambon*	*Nangka*	Wheat
Color	L	$63,08 \pm 2,27^{bc}$	$61,01 \pm 1,60^{b}$	$66,53 \pm 2,84^{c}$	$82,01 \pm 2,81^{a}$
	a*	$1,15 \pm 0,09^{c}$	$1,86 \pm 0,11^{b}$	$0,39 \pm 0,20^{d}$	$-4,59 \pm 0,16^{a}$
	b*	$17,49 \pm 0,3^{b}$	$17,06 \pm 1,54^{b}$	$18,92 \pm 0,84^{b}$	$31,36 \pm 1,51^{a}$
Hardness (gf)		$158,18 \pm 3,39^{b}$	$167,45 \pm 7,17^{bc}$	$196,53 \pm 4,83^{c}$	$319,53 \pm 8,88^{a}$

Parameter	Type of Flour*			
	Kepok	*Ambon*	*Nangka*	Wheat
Volume Expansion (%)	48,51 ± 0,20[a]	48,78 ± 0,58[a]	48,85 ± 0,33[a]	53,95 ± 0,99[b]
Potassium (mg/100g)	44,9 ± 3,8[a]	53,8 ± 2,4[b]	58,5 ± 0,8[c]	-

**) Mean ± SD of duplicate determinations (n=9). Values with different superscripts differ significantly (p < 0.05).*

Hedonic test that was performed by 40 respondents shows that kepok flour cake is the least liked than others (Table 3). The most liked cake is the wheat flour cake; but, it has no significant difference with *nangka* banana cake.

Table 3: Hedonic rate on the steamed cakes

Type of Flour	Parameter*				
	Aroma	Color	Texture	Taste	Overall
Kepok	2,48±1,24[b]	2,78±0,95[bc]	3,25±0,90[a]	2,95±0,93[c]	2,80±0,82[b]
Ambon	3,55±0,85[a]	2,88±0,94[b]	3,63±0,84[a]	3,50±0,91[ab]	3,45±0,68[a]
Nangka	3,20±1,18[a]	2,35±0,98[c]	3,05±0,96[a]	3,20±0,97[bc]	3,03±0,83[b]
Wheat	3,55±1,11[a]	3,68±1,19[a]	3,40±1,03[s]	3,73±0,75[a]	3,73±0,78[a]

**) Mean ± SD of duplicate determinations (n=9). Values with different superscripts differ significantly (p < 0.05).*

For color, panelists prefered the color of wheat flour cake the most. Meanwhile, for texture (hardness and ease of swallowing), there is no significant difference of preference between samples. For aroma and taste, wheat flour cake achieves the highest score compared to *kepok* and *nangka* banana cakes but has no significant difference with *ambon* banana cake. When judging the overall attributes, the steamed cakes made of *ambon* banana and wheat flour are the most prefered by respondents.

4 CONCLUSIONS

Among three banana varieties, *nangka* banana flour produces higher yield, starch, and potassium content, while *ambon* banana flour has brighter color and higher fiber content. For steamed cakes, the wheat flour cake has brighter appearance, harder texture and higher volume expansion. For overall attribute of sensory, there is no significant difference between wheat and *ambon* banana cakes in term of hedonic rating.

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Tel: (84)(28) 38225062 Fax: (84)(28) 38296628

Email: chinhanhnxbkhkt@yahoo.com.vn

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