Physicochemical Characteristics of Sun-dried and Roasted Cassava Rice

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ABSTRACT

High demand of rice can be minimized by promoting cassava as an alternative carbohydrate source. One method to process cassava to ease consumption and to prolong its shelf-life is by making it into analog rice, namely cassava rice. Two drying methods were studied to obtain the physicochemical information of cassava rice. This research aimed at determining color and chemical properties, i.e. water content, ash, lipid, protein, carbohydrate, starch, amylose, amylopectin, and mineral contents of cassava rice processed by roasting and sun-drying. It also compared physicochemical characteristics of cassava rice and paddy rice to get better understanding of nutritional values of cassava rice. Results showed that physical, chemical, and mineral contents of cassava rice were different from paddy rice. Cassava rice had lower water, protein, Zn and P2O5 contents than paddy rice. Roasted cassava rice was darker than cassava rice. Sun-dried and roasted cassava rice showed no different values in terms of lipid, carbohydrate, starch, amylose, amylopectin, Mg, Zn and P2O5 contents, while other characteristics were similar.

Keywords: Cassava rice; physical and chemical characteristics; roasted; sun-dried

INTRODUCTION

Carbohydrate is the main energy source which provides more than 50% of required total daily energy. In Indonesia, some carbohydrate sources include rice, corn, potato, cassava, sago, or other tubers. Rice consumption in Indonesia is still considered high which is 29.57 million tonnes in 2018 (Subdirektorat Publikasi dan Kompilasi Statistik, 2019). However, there was a decline in rice consumption from 107.7 kg per capita per year in 2002 to 98.05 kg per capita per year in 2015 (Sabarella *et al.*, 2016) which may due to the increase of consumption of wheat flour-based food such as pasta, bread, and noodle.

Cassava stands the second as a staple food after rice. In the past five years, cassava production was around 21 - 24 million tonnes per year, while consumption was around 10 – 16 million tonnes per year (Widaningsih *et al.*, 2016). Compared to other carbohydrate sources, cassava is the most potential sources to alternate rice due to its great energy value. The value of energy produced from cassava, sweet potatoes, potatoes, and sweet corn are 160 kcal, 125 kcal, 77 kcal, and 86 kcal, respectively (Sánchez *et al.*, 2014)only few samples can be quantified each day for total carotenoids (TCC.

Cassava is usually consumed by steamed, fried, or made into flour (Haryadi, 2011). Cassava can also be made into analog rice namely *beras singkong* or cassava rice. The process of making cassava rice involves two times of drying. First is drying done before steaming and second is drying done after steaming. Drying usually done under sunlight which makes difficult to process on rainy season. Therefore, on this study roasting was applied in the second drying process to reduce long drying process under direct sunlight. Although cassava rice has already been consumed in Indonesia especially in Central Java, East Java, South Sumatra, and Lampung, study on physicochemical characteristics of cassava rice has not been conducted. The objective of this study was to explore the effect of sun-drying and roasted methods on physical and chemical characteristics of cassava Ice and to investigate whether roasted method would result in shorter drying time with no significant difference in quality. Comparison of cassava rice and paddy rice was done since both products were usually categorized as staple food as carbohydrate sources.

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RESEARCH METHODS

Materials

Cassava were collected from a local farm of Yogyakarta, Indonesia and a paddy rice (variety of Menthik Wangi) was derived from lowland at Yogyakarta, Indonesia. Variety of cassava was unknown but it was white cassava. Menthik Wangi rice was a conventional rice from paddy having small and flat shape, white-colored, and fragrant smell.

Methods

Cassava rice making using roasted and sun-dried method

Cassava rice was made based on common traditional procedure including utensils used. Cassava rice was sliced into 5-10 cm length then soaked in water for 3 days. Cassava was then mashed, squeezed, and sieved using a bamboo sieve resulted in grain. For sun-dried cassava rice, the crystal shaped cassava was dried under the sun until mid-dry then steamed. Finally, the cassava was dried again under the sun until fully dry. Figure 1 showed the making process of cassava rice. The duration of sun drying depends on the climate condition, usually 6-8 hours in dry season but is longer in rainy season. For roasted method, instead of drying under the sun, the crystalized cassava right after sieving were steamed and then roasted on the pan using a household gas stove at temperature of 100° C for 30 minutes or fully dry. There was no specific water content for cassava rice during steaming. The purpose of steaming was to expand the structure of grains.

Physical characteristics analysis

The physical characteristics analyzed from cassava rice is color values measured using a Chroma Meter (Konica Minolta CR-400, Japan). All the experiments were done in triplicate and results were presented as mean values. Color analysis was conducted on Menthik Wangi rice, roasted cassava rice, sun-dried cassava rice with attributes of lightness (L), hue (H) and chroma (C). Lightness represents darkness at L=0 and brightness white at L = 100. Hue is the main properties of a color. Chroma was defined as the quality of a color's purity, intensity or saturation.

Chemical and mineral composition analysis

The chemical composition of cassava rice were moisture, ash, lipid, protein, carbohydrate, starch, amylose, and amylopectin content. Moisture content analysis was done using gravimetric method in which the sample was heated and the weight loss due to evaporation of moisture was recorded. All of the chemical compositions were analyzed according to AOAC standard method (Horwitz and Latimer, 2005). The results were reported on dry basis. All the experiments were done in triplicate and results were presented as mean values.

The mineral composition of cassava rice were calcium, magnesium, potassium, zinc, and phosphorus pentoxide (P_2O_5) content. All of the mineral compositions were analyzed according to AOAC method (Horwitz and Latimer, 2005). All the experiments were done in triplicate and results were presented as mean values.

Figure 1. Process of cassava rice making including (a) mashing cassava after soaking for 3 days, (b) sieving using bamboo siever, and (c) dried cassava rice

Statistical analysis

The data reported were the average of triplicate observations. Data obtained were analyzed by single factor analysis of variance (ANOVA) using SPSS (SPSS Inc, Chicago, IL, USA). Comparisons of means were made using Duncan's test.

RESULTS AND DISCUSSION

Color

The lightness values due to different cooking methods were 58.42 ± 3.06 (mean ± SD) for roasted and 59.50 ± 2.15 for sun-dried cassava rice as shown in Figure 2. The chroma values of cassava rice with different cooking methods were 80.58 ± 0.71 for roasted and 82.10 ± 0.71 for sun-dried. The high chroma value for roasted cassava rice indicated that it had darker yellow color than sun-dried cassava rice. Both rice had significant difference ($\alpha<0.05$) in term of chroma values. The hue values of cassava rice with different cooking methods ranging from 80.58 to 82.10 meaning that the color was yellow. There were significant differences ($\alpha<0.05$) in lightness, chroma, and hue values for roasted and sun-dried cassava rice.

The high lightness value of sun-dried cassava rice indicated a brighter color than roasted cassava rice since the drying temperature of a pan used for roasting was higher than direct sunlight. The higher temperature of pan used in roasting cassava rice resulted in the darker cassava rice than the rice processed under sunlight. The high temperature of the pan for roasting cassava rice although required shorter process produced darker color than sun-dried cassava rice. The higher hue value (82.10) was sun-dried cassava rice indicating sun-dried cassava rice was less yellow compared to roasted cassava rice. Reducing sugar of cassava was around 0.31 – 2.62 g/100 g for white and yellow varieties, respectively (Eleazu and Eleazu, 2012). Although the concentrations were very low, free amino acids existed in processed cassava (Ambein, 2002). Chemical reactions between reducing sugars and amino compounds in cassava which undergo thermal processing either roasting or sun-dried produced a Maillard reaction. This reaction will speed up with the increase of temperature. Therefore, casava rice made by roasting have yellow darker color compared to sun-drying process since the the higher temperature used in roasting.

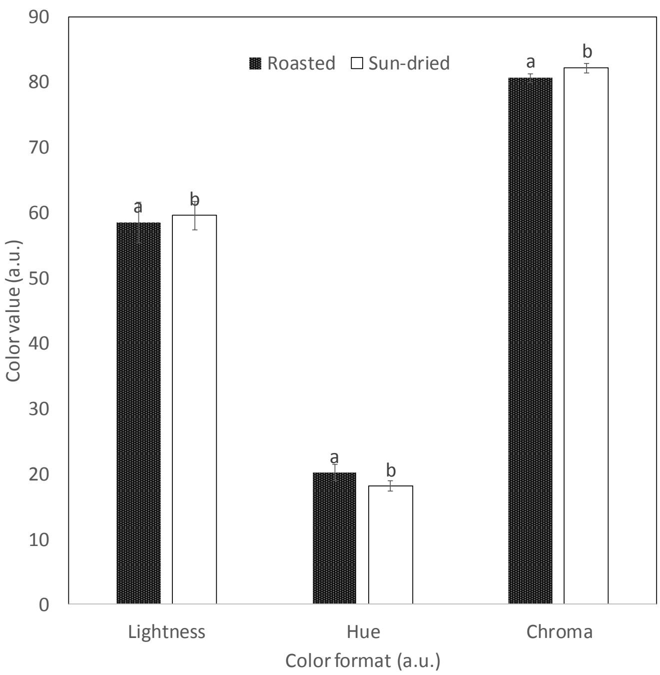

Figure 2. Lightness (L), Chroma (C), and Hue (H) color value of sun-dried and roasted cassava rice

Chemical composition of cassava rice

Table 1 showed chemical compositions of roasted cassava rice, sun-dried cassava rice, and Menthik Wangi rice. Water content of cassava rice was lower compared to Menthik Wangi rice. Water content of cassava rice either processed by roasting or sun-drying were considerably lower which was less the 12% potential for longer storage life (Aryee *et al.*, 2006). Similar trend were on lipid and protein of Menthik Wangi rice which were higher than cassava rice.

In term of protein, cassava had significant lower value compared to other source of carbohyrate such as rice and corn (Zuraida and Supriati, 2001). Protein in rice was about 7.75–10.73% (Syafutri *et al.*, 2016) while in corn was about 8–11% (Suarni and Widowati, 2007).

Table 1. Chemical contents of cassava rice and Menthik Wangi rice (% of dry weight)[1]

Chemical composition	Menthik Wangi Rice	Cassava rice	
		Roasted	Sun-dried
Water (%)	14.37[c]	10.50[a]	11.49[b]
Lipid (%)	0.22[b]	0.06[a]	0.07[a]
Protein (%)	6.97[b]	0.93[a]	0.89[a]
Carbohydrate (%)	78.13[a]	87.99[c]	87.08[b]
Starch (%)	78.14[a]	87.87[b]	87.59[b]
Amylose (%)	15.03[a]	22.49[b]	22.42[b]
Amylopectin (%)	63.11[a]	65.38[b]	65.16[b]

[1] Mean values in a column followed by the same letter in each sample are not significantly different

Higher protein content in Menthik Wangi rice compared to cassava rice will result in longer time of cooking for conventional rice since protein inhibited the absorbtion of water (Syafutri *et al*., 2016).

Starch consisted of amylose which has a smaller molecular weight and few long branches as well as amylopectin which has a higher molecular weight and has high branched glucose polymers and great amount of short branches (Syahariza, *et al*., 2013). There was no significant difference of starch, amylose, and amylopectin content of roasted and sun-dried cassava rice indicating that cooking methods in making cassava rice were insignificantly affect starch and its molecul contents. Gelatinization is a process when starch combined with water and heated, its granules absorb the water and swell. For cereals such as rice, gelatinization occurs at higher temperatures, while for tubers such cassava it occurs at lower temperatures. Amylopectin in cereals affected swelling, but in contrast lipid and amylose content inhibited swelling (Tester and Morrison, 1990)based on the observation that blue dextran dye (molecular weight 2 x 10(6. Amylose significantly affects texture of grains. High amylose resulted in non-sticky and hard granules, as well as easy to expand. Rice used in this research was categorized as low amylose class since it ranged between 10–20%. Cassava rice made in this research had high amount of amylose shown by its crystallized and hard texture.

Mineral composition of cassava rice

Mineral contents of cassava rice, especially for calcium, magnesium and zink, were similar to other legumes. Cassava processing into rice comprising soaking and drying affected nutritional value (Montagnac *et al*., 2009), therefore mineral contents of cassava rice were lower than unprocessed cassava root. Table 2 showed mineral contents of Menthik Wangi rice as well as roasted and sun-dried casava rice. Ca, Mg, and K contents of Menthik Wangi rice were considerably lower than cassava rice. On the other hand, Menthik Wangi rice contained considerable Zn and P_2O_5 content compared to cassava rice. Cassava rice made by roasting or sun-drying did not show significant different in terms of Mg, Zn, and P_2O_5 contents. However, there were significant difference in Ca and K contents of cassava rice either processed using roasting or sun-drying.

Table 2. Mineral contents of Menthik Wangi rice and roasted and sun-dried cassava rice[1]

Mineral composition	Menthik Wangi rice	Cassava rice	
		Roasted	Sun-dried
Ca (ppm)	19.20[a]	177.08[b]	195.32[c]
Mg (ppm)	103.34[a]	261.75[b]	262.25[b]
K (ppm)	606.87[a]	1321.69[b]	1183.41[c]
Zn (ppm)	14.74[a]	3.39[b]	3.06[b]
P_2O_5 (mg/100g)	190.00[a]	170.89[b]	167.27[b]

[1] Mean values in a column followed by the same letter in each sample are not significantly different

CONCLUSION

There were some differences in physical, chemical, and mineral contents of sun-dried and roasted cassava rice. In term of color, roasted cassava rice had a darker color compared to sun-dried cassava rice. There were no difference in terms of lipid, carbohydrate, starch, amylose, amylopectin, Mg, Zn, and P_2O_5 of sun-dried and roasted cassava rice. In order to alternate rice as staple food, cassava rice contains similar amount of carbohydrate (%), starch (%), amylose (%), and amylopectin (%) to paddy rice. However, water content, protein, Zn and P_2O_5 of paddy rice were higher than cassava rice.

CONFLICT OF INTEREST

This manuscript has not been published at another journal. The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.

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