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Physico-Chemical Properties, Sensory Characteristics and Glycemic Index of Tidal Peat-Swamp Rice Grown in South Kalimantan

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Abstract: *"Panjang" rice is an ethnic rice strain found in a tidal peat swamp Aluh-Aluh, South Kalimantan. A series of analyses on its sensory and physico-chemical properties included proximates, mineral content, amylose content, starch gelatinization, grain size and color were carried out to compare its quality to that of the commercial wet-land rice. Its glycemic index was also measured to explore its low glycemic potency. "Panjang" rice was classified as a medium sized grain (5.50 mm length) with high amylose content of 31.1% (db), gelatinized at 77.3°C with gelatinization peak at 97.5°C and maximum viscosity at 637.5 BU. There were significant differences between "Panjang" rice and IR 42 in ash, fat, protein, carbohydrate, and mineral (Na, S and P) contents, amylose content as well as grain brightness. No significant ($p<0.05$) difference was observed in sensory properties between "Panjang" and""IR 42" cooked rice, except that no bitter taste was sensed in "Panjang" rice . Based on its glycemic index, which"was as low as 46.8, "panjang" rice can be classified as low glycemic index rice.*

Keywords: "Panjang" rice, tidal peat-swamp, physico-chemical properties, sensory, glycemic index

INTRODUCTION

Rice is a staple food to most Indonesians. However, the high consumption of rice is not supported by the domestic rice production. Indonesia is the biggest rice importer in the world. Total rice import of Indonesia in year 2003 was 1.6 million tons (IRRI, 2005).

Kalimantan Island has 2 million hectares of tidal peat moss soil, where only 135,000 hectares is planted with rice (Noorsyamsi *et al.*, 1984). Most of the planted rice is ethnic such as "Bayar Kuning", "Bayar Putih", "Pandak Putih" and "Siam Dukuh". Their productivity is only 1.0 – 2.5 tons ha^{-1}. South Kalimantan is the biggest rice producer in Kalimantan Island; with the amount of production in year 2004 standing at 1.5 million tons of rice grain (BPS, 2005).

"Panjang" rice which is also called "Padi Panjang" is ethnical rice which was found in Aluh-Aluh district, South Kalimantan, in 1990 by local farmers. The height of the rice reaches 2.5 m, and the stalk 50 cm long. It's productivity is high, reaching 6.7 tons grain yield ha^{-1}, without any nitrogen fertilizer application (Purnomo *et al.*, 2004). It is cultivated in tidal peat swamp, a sulphonic land which is high in acidity, rich in organic elements and high in mineral contents.

Despite its potential productivity, there are few reports about "Panjang" rice. Since "Panjang" rice has a great potential to be produced on a commercial basis for food, it is important to study its food quality including the physico-chemical attributes of its grain, nutrient aspects as well as its flavor characteristics compared with the existing

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established commercial rice in the market. Therefore, this research was carried out to obtain more scientific information of "Panjang" rice regarding the sensory, physical and chemical attributes of its grain, as well as the glycemic index of its rice. The glycemic index was measured to examine the other biochemical characteristics of this "Panjang" rice.

MATERIALS AND METHODS

Dried milled "Panjang" grain was obtained from the Department of Soil Science, Lambung Mangkurat University and dried milled IR-42 grain was obtained from the local market in Bogor. Basmati grain (Tilda Brand, Australia) was bought in Jakarta Supermarket in hulled shape and ready to use.

The dried milled "Panjang" grain and dried milled IR-42 grain were de-husked and hulled to get total hulled rice.

IR-42 rice was used to compare with the "Panjang" rice for physical and chemical attributes and sensory analysis, while Basmati rice was used for comparison of the glycemic index.

Pure amylose (Sigma, USA), glucose standard, mineral water and other chemicals utilized for the measurements were obtained from Brataco chemical supplier in Bogor. Flavor standards such as lauric acid, diacetyl, acetyl methyl carbinol, oat meal, aldehyde C-10 and lactone C-10 were obtained from PT Ogawa, Indonesia.

Chemical Analysis

Proximate analysis included moisture, ash, lipid, protein, and carbohydrate (*by-difference*) contents using the method of AOAC (1995). Amylose content measurement was done based on Juliano method (1971).

Phosphorus content analysis was done using Vanadat-Molibdat method (AOAC, 1995), while Na, S, and Fe analyses were done using the Atomic Absorption Spectrophotometer (AAS).

Physical Analysis

The length of "Panjang" and IR-42 grain were calculated"based on the mean measurements of the length of 15 grains in a row using a ruler (Hettiarachchy *et al.*, 1999).

Color analysis with the Hunter Method was used to measure the L-value parameter. The L-value symbolizes brightness with 0 (dark) to 100 (bright) scales (Hutching, 1999).

Gelatinization analysis was carried out by using Brabender-amylograph on 60 mesh rice powder. Gelatinization initial temperature, maximum gelatinization temperature and maximum viscosity can be read from the Brabender-amylograph.

Sensory Analysis

The sensory characterisation of "Panjang" and IR-42 cooked rice was done using the flavor descriptive method.

Selection of Panelists and Training

Among 40 college students of Food Science and Technology Department, 10 capable panelists were selected for Quantitative Descriptive Analysis (QDA). Triangle test and sensory detection on taste and smell were used for the selection (Meilgaard *et al.*, 1999). Panelists passed the test if they achieved 60% correct answers for the triangle test and 80% correct answers for the detection test (Meilgaard *et al.*, 1999).

Panelist training was done for 3 months, consisting of *flavor language* (flavor terminology) introduction, scale introduction, and evaluation skill for all the specific samples (Stone and Sidel, 2004).

Focus Group

A focus group was created to decide which sensory attributes were present in qualitative terms in "Panjang" and IR-42 rice.

Standard Flavor Concentration

The decision for standard flavor concentration was done based on Maskowitz Law (1983), where the panelists evaluate the intensity from

specific flavor in a 15 cm length unstructured scale.

Quantitative Descriptive Analysis (QDA)

QDA was done to determine the intensity of each flavor attribute that was decided by the focus group. The result of QDA is shown in spider-web form.

Glycemic Index Analysis

Glycemic index analysis was done by using human blood (*in vivo*). The panelists were 10 persons, with normal Body Mass Index (BMI) and non-diabetic (El, 1999).

Fifty grams glucose was dissolved in 200 ml mineral water as a standard. The tested rice that was consumed by the panellists was equivalent to 50 g of total carbohydrate (wet base). The determination of total carbohydrate in rice was *by-difference*.

The glycemic index was measured by comparing the vast curve of panelists sugar blood, which increased after the consumption of rice with the standard vast curve (Marsono *et al.*, 2002). The measurement of sugar blood level was done every 30 minutes for two hours, starting from the time each panelist consumed the sample or standard.

Figure 1: "Panjang" rice compared to the other local rice

Table 1: Chemical properties of "Panjang" and IR-42 rice

Content	"Panjang" Grain (%)*	IR-42 Grain (%)*
Moisture	13.2	13.2
Ash	0.8	1.1
Protein	6.7	9.7
Lipid	0.2	0.5
Carbohydrate	92.3	88.7
Amylose	31.1	27.1

*dry basis

RESULTS AND DISCUSSION

Physical Appearance

The word "Panjang" means long paddy, which reflects why""Panjang" rice has longer paddy panicles comparing to other local rice (Figure 1) (Purnomo *et al.*, 2004). There were, however, no major differences in color, shape and average size of the unhulled rice.

"Panjang" rice is characteristically normal in appearance similar to either local paddy or wet-land paddy namely IR-42, "Cianjur", "Pandan wangi"and others.

Proximate and Amylose Content

"Panjang" rice showed lower ash, protein and lipid content compared to IR-42 rice. This indicates that the carbohydrate content of "Panjang" rice is higher than in IR-42 rice. The proximate data of "Panjang" and IR-42 are shown in Table 1. The ash, lipid, protein and carbohydrate content of "Panjang" were significantly different ($p<0.05$) to IR-42.

Amylose content has been used as a basic parameter for classification of rice. Based on their amylose content (dry base), rice can be classed as: (1) waxy rice (0 – 2.9%), (2) very low amylose rice (3 – 9.9%), (3) low amylose rice (10 – 19.9%), (4) medium amylose rice (20 – 24.9%), and (5) high amylose rice (>25%) (Juliano,1979). "Panjang" rice contains more amylose compared to IR-42 rice. The amylose content of "Panjang" and IR-42 rice was 31.1% and 27.1% (dry base) respectively. Therefore, "Panjang" and IR-42 rice can be classified as high amylose rice (*beras*

pera-non sticky) and also considered as "long grain-type".

Mineral Contents

For the four minerals measured, P content was highest in both "Panjang" and IR-42 rice. The result is similar to that of Hoseney (1998), who reported that P content in rice is higher compared to other elements. The results of mineral content analysis are shown in Table 2.

Table 2: Mineral contents of "Panjang" and IR-42 rice

Mineral	"Panjang" (ppm)	IR-42 (ppm)
Fe	21	20
Na	275	131
S	800	500
P	2900	900

"Panjang" rice contained significantly ($p<0.05$) higher amounts of Na, P and S compared to IR-42. The high Na content in "Panjang" rice is probably due to the"cultivation location, which is a tidal area that is intruded by sea water with high Na content. The higher content of sulfur can be explained by the effect of pyrite (FeS_2) oxidation in soil. It has been reported that peatland naturally contain high amounts of sulfur (Purnomo *et al.*, 2004). However, from the results of this study, there was no significant difference between "Panjang" rice and IR-42 for iron content. The wide variation between Fe content in acid-sulfate soil and non acid-sulfate soil did not have any effect on the Fe content in rice. This may be due to the ability of "Panjang" rice to tolerate Fe toxicity that usually affects other paddies planted in acid-sulfate soil (Purnomo *et al.*, 2004).

Physical Characteristics

"Panjang" and IR-42 grains can be classified as medium-sized rice. No significant ($p>0.05$) differences in grain length were observed between "Panjang" and IR-42 rice, which were 5.5 and 5.7 mm respectively (Table 3).

Table 3: Color and length of "Panjang" and IR-42 rice

Rice	L (brightness)*	Length (mm)
"Panjang"	79.02	5.50 (medium grain)
IR-42	68.79	5.70 (medium grain)

* scale = 0 (dark)-100 (bright)

Results in Table 3, of L-Value measurement showed that "Panjang rice"grain was brighter than IR-42 rice grain and statistical t-test analysis showed that L-value of "Panjang" grain was significantly different ($p<0.05$) to that of IR-42. The difference in brightness probably is due to the higher content of amylose since waxy rice grains with higher amylopectin and lower amylose content usually appear milky or cloudy.

"Panjang" rice had a gelatinization initial temperature higher than that of IR-42 rice, with values of 77.3 and 67.5°C respectively (Table 4). This might be due to the higher amylose content in "Panjang" rice. It was reported that high amylose starch (corn) requires high temperature for gelatinization (Luallen, 1985). It might also indicate the smaller size of starch granules of "Panjang" compared to IR-42 (deMan, 1999). The higher gelatinization temperature influences the cooking time of the grain. "Panjang" rice needs longer cooking time than IR-42. The gelatinization peak of "Panjang" rice was 97.5 °C and maximum viscosity was 637.5 BU which was higher than that for IR-42 (Table 4).

Sensory Characteristics

The sensory attributes of "Panjang" and IR-42 cooked rice based on the perception of the *focus group* are shown in Table 5. Bitter taste is the only attribute that was different between "Panjang rice and IR-42 rice. There was a

Table 4: Physiscal characteristics of "Panjang" and IR-42 rice recorded by Brabender-amylograph

Rice	Gelatinization temperature (°C)	Temperature of peak viscosity (°C)	Maximum viscosity (BU)
"Panjang"	77.3	97.5	637.5
IR -42	67.5	93.7	515.0

Table 5: Sensory attributes of "Panjang" and IR-42 rice based on *Focus Group*

Rice	Aroma / Scent	Taste
"Panjang""	*Waxy, Buttery, Creamy, Cereal*	Sweet, salty
IR-42	*Waxy, Buttery, Creamy, Cereal*	Sweet, salty, bitter

bitter-note sensed in IR-42 which was not detected in "Panjang" cooked rice.

The concentration of flavor standards that were used as anchor point for panelists to evaluate the sample was determined by Maskowitz Law. The anchor point in this research had Sensory Intensities (SI) 25 and 50. The QDA results are shown as a spider web (Figure 2).

waxy, creamy-notes and a weak buttery character. The intensity of *buttery*, *creamy* and *waxy* aroma of "Panjang" cooked rice was slightly higher than IR-42 cooked rice. The sweet-taste intensity of "Panjang" was a little higher, while the salty-intensity was lower than IR-42 cooked rice but not significantly different. The bitter attribute of IR-42

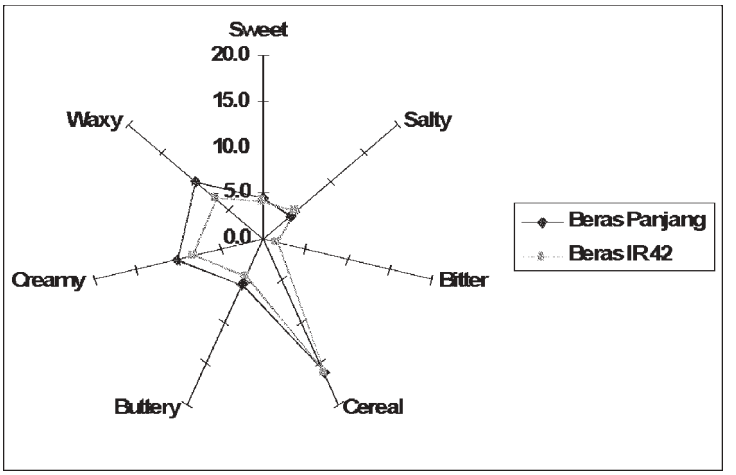

Figure 2: Quality descriptive analysis of "Panjang" and IR-42 rice

Cereal flavor is the dominant aroma in "Panjang" and IR-42 cooked rice, followed"by appeared in lower intensity than the other two attributes, sweet and salty.

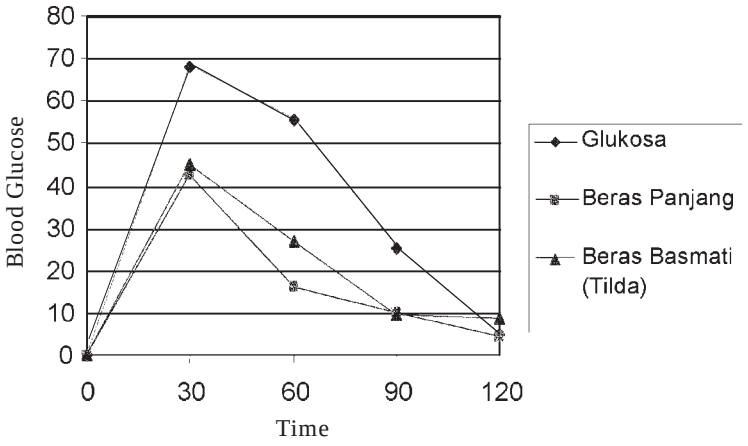

Figure 3: Glycemix index of "Panjang" and IR-42 rice

In general, "Panjang" rice has similar flavor attributes with IR-42 except for the bitter-note. The dominant aroma of "Panjang" rice is *cereal*, combined with *creamy*, *waxy*, and *buttery*, while the taste of "Panjang" rice is salty and sweet in light intensity.

Glycemic Index

The glycemic index (GI) was measured and compared between "Panjang" and Basmati" rice. Basmati"rice was used for comparison because it has a common and consistent GI (Foster-Powell *et al.*, 2002).

The GI ranks carbohydrate food on how quickly the carbohydrates enter the bloodstream and elevate blood sugar levels. This index is measured by comparing the blood glucose elevation effect of 50 grams from a particular carbohydrate food with the blood glucose elevation effects of 50 grams of glucose as the standard (El, 1999).

The result showed that "Panjang" has low GI than Basmati rice. The glycemic index of "Panjang" and Basmati rice were 46.8 and 56.8, respectively. The result for Basmati was similar to previous GI of 58 reported by Foster-Powell *et al.*, (2002) and Carbohydrates Information (2006). From these results "Panjang" rice can be categorized as a low GI food substance (< 55) (El, 1999), The blood sugar elevation over time after consumption of "Panjang" rice, Basmati rice and glucose (standard) are shown in Figure 3.

CONCLUSION

"Panjang" rice can be classified in the same category with IR-42 (commercial rice) as medium size rice grain with high amylose content. However, it showed some differences in physico-chemical charateristics. This rice has lower fat, ash and protein content. Although it is lower in ash content, it showed higher content for Na, S and P compared to IR-42. "Panjang" rice grains are brighter, have higher gelatinization intial temperature and maximum viscosity which contribute to its utilization for many purposes. Meanwhile, its similarity in sensory attribute with IR-42 cooked rice can maintain its acceptability as normal rice. The dominant aroma flavor of "Panjang" rice is *cereal-like*, combined with *creamy*, *waxy*, and *buttery*, while the taste of "Panjang" rice has been described as slightly sweet and salty without bitter-note. Panjang rice also showed low glycemic index, which is an outstanding characteristic for its potential as functional food or ingredient. "Panjang" rice showed adequate characteristics for it to be used as commercial rice.

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