Nutritional composition and organoleptic quality of instant local black rice (cempo ireng) with moderate glycemic index

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Abstract. This research aims to develop instant rice from local black rice variety, Cempo Ireng, that is safe for diabetes mellitus. Instant black rice was made through the process of soaking in sodium citrate, washing, cooking using a rice cooker, freezing in the freezer for 24 hours, thawing at room temperature, and drying using a dehydrator. There were 3 formula of instant black rice including (1) soaking in 5% sodium citrate at room temperature, (2) soaking in 5% sodium citrate at 50^0C, (3) soaking in 7% sodium citrate at 50^0C. All formulated instant black rice was then tested for its nutritional content (including anthocyanin, dietary fiber, amylose, amylopectin, starch, water content, ash, protein, fat, and carbohydrates). The black rice formula is also tested for hedonic quality by 35 semi-trained panelists. The formula 7% sodium citrate at 50°C has the highest score in color. The formula 7% sodium citrate at 50°C and 5% sodium citrate at room temperature have the same score for the rice aroma. The third formula was the best formula based on the panelists' choices and anthocyanin content. It was then tested for its glycemic index. The results showed that instant black rice has a moderate glycemic index of 60.

1 Introduction

One of the eating patterns that is often applied by Indonesian society today is the consumption of instant food that is easy and fast in processing and presentation. Instant food becomes an alternative food that is developed [1]. However, instant foods that are currently circulating on the market, such as cornflakes and instant noodles, tend to have a high glycemic index (GI). High GI food can lead to rapid increases in blood glucose levels after consumption,

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thereby increasing the risk of diabetes mellitus in consumers [2]. Therefore, instant food with a low GI is needed. Black rice with its high anthocyanin content, low GI, and high fiber, is suitable for development into a healthy instant product [3]. Research show that instant rice process could be affected the nutritional quality and sensory characteristic of rice [4]. There is limited research about the effect of instantization on black rice quality. Therefore, this research aims to determine nutritional composition, glycemic index, and organoleptic quality of instant Cempo Ireng.

2 Materials and methods

Cempo ireng as a local black rice variety from Indonesia undergoes several processes to become instant rice. The treatments in this research were at the soaking stage included sodium citrate concentration (5% and 7%) and soaking temperature (room temperature and 50ºC).

2.1 Sample preparation

First cempo ireng is thoroughly washed to remove any dirt or impurities. Then it soaked in sodium citrate at different temperature (5% sodium citrate at room temperature, 5% sodium citrate at 50ºC, and 7% sodium citrate at 50ºC). After 2 hours of soaking, rice was cooked using a rice cooker. The cooked rice was frozen for a night. The cooled rice is then dried using a dehydrator for 20 hours. This process removes most of the moisture from the rice, making it shelf-stable. The dried rice is once again cooled down to room temperature. At this point, black rice has become an instant rice.

2.2 Nutritional content analysis

Nutritional content analysis of three instant black rice formulation including anthocyanin, dietary fiber, amylopectin, amylose, starch, proximate analysis (ash, moisture, fat, protein, carbohydrate, energy from fat, and total energy).

2.3 Hedonic test

About 35 panelists were involved in the hedonic test. Panelists were asked to evaluate the color, taste, aroma, texture, and aftertaste of the three instant black rice samples by filling out an organoleptic test form. Panelist gave rate to instant black rice product by likert scale with five response options including (1) extremely dislike, (2) moderately dislike, (3) neither like nor dislike, (4) moderately like, (5) extremely like.

2.4 Glycemic Index test

Thirty-one participants underwent initial screening. Based on screening results, 20 subjects met the inclusion and exclusion criteria. Inclusion criteria were as follows: male or female subjects aged 18-30 years with a normal body mass index (BMI) of 18.5-22.9 kg/m², no history of diabetes mellitus, no allergy to the test food (black rice), no gastrointestinal disorders, not taking any medications that could affect blood glucose levels, no alcohol or tobacco consumption, willingness to participate in the study, and provision of written informed consent. Subjects in the glycemic index (GI) test selected using purposive sampling. However, only 11 individuals completed the study and their data were used in the analysis of the glycemic index of black rice. Participants were given 50 grams of anhydrous glucose as

a standard food on two occasions with a one-week interval. Instant black rice containing 50 grams of available carbohydrate was rehydrated using hot water before being administered to the participants. Blood glucose were measured at a fasting state, at 15, 30, 45, 60, 90, and 120 minutes postpandrially. Ethical clearance was obtained from the Ethics Commission number: DP.04.03/F.XXI.31/947/2023.

2.5 Statistical analysis

Data from hedonic tests of three instant black rice was analyzed by transforming hedonic scale data into into five levels of preference that can be statistically tested. The blood glucose levels of respondents in the glycemic index test are entered into a combination graph between the x-axis (time of blood glucose sampling in minutes) and the y-axis (blood glucose level in mg/dl). The calculation of the glycemic index value for each subject is obtained from the comparison of the area under the curve of the test food against the reference food by ignoring the curve that is below the fasting blood sugar level (incremental area under the curve or iAUC). The GI value of instant rice is obtained from the average of the glycemic index values of all subjects. The results of the measurement of the product's GI are then categorized into low (<55), medium (56-69), and high (>70).

3 Results and discussion

Instant black rice that soaking with 7% sodium citrate at 50^{O}C was chosen as the best formula based on its highest anthocyanin content (40.26 mg/kg) (Table 1) and its organoleptic quality (Fig.1). The best formula then used as a tested food for glycemic index test.

Table 1. Nutritional content of three instant black rice formula

Nutritional content	5% sodium citrate at room temperature	5% sodium citrate at 50 ^{o}C	7% Sodium citrate at 50^{o}C
Anthocyanin (mg/kg)	31.64	34.71	40.26
Dietary fiber (%)	7.67	7.94	7.85
Amylopectin (%)	20.93	22.09	24.89
Amylose (%)	5.89	5.06	4.96
Starch (%)	26.83	27.15	29.85
Ash (%)	0.78	0.85	0.78
Moisture (%)	62.41	59.88	60.27
Fat (%)	2.49	2.71	2.74
Protein (%)	9.41	9.7	9.48
Carbohydrate (%)	24.90	26.87	26.74
Energy from fat (Kcal)	22.36	24.39	24.64
Total energy (Kcal)	159.63	170.65	169.49

Black rice that soaking with 7% sodium citrate at 50ºC has the highest anthocyanin content. Anthocyanin is a class of compounds that regulating plant color and known to have a promising antioxidant and anti-inflammatory effect. Some study shows that anthocyanin significantly reduced the risk of some diseases such as type 2 diabetes mellitus and hypertension [5,6]. Consumption of anthocyanins in some condition also imply a good effect on gastrointestinal microbiota [7]. Thus, this finding implies that instant black rice has a good potential as a healthy instant food.

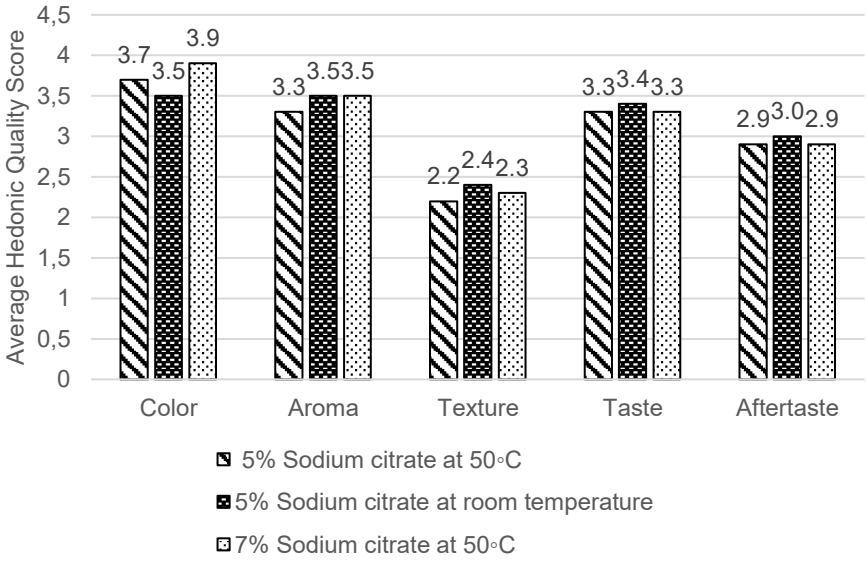

Fig 1. Hedonic test results of three instant rice formula

The results of the hedonic quality test analysis show that there are no significant differences in hedonic quality among the three formulas in terms of color, rice aroma, texture, or taste (Kruskal-Wallis test $p>0.05$). The formula 7% sodium citrate at 50°C has the highest average score in terms of color (Fig.1). The Formula 7% sodium citrate at 50°C and 5% sodium citrate at room temperature have the same average score for the rice aroma aspect. Thus, 7% sodium citrate at 50°C formulation was chosen to be a tested food for glycemic index test.

Glycemic index (GI) provides information about the ability of carbohydrate in foods to influence blood glucose levels. The carbohydrates in high-GI foods are digested and absorbed more rapidly, leading to a significantly greater elevation in blood glucose levels [8]. GI test results show that instant black rice has a lower blood sugar rise trend than glucose. Instant black rice soaked in 7% sodium citrate at 50°C has a moderate glycemic index (60). Moderate-GI foods may have health benefits in terms of glycemic control in diabetes compared to high-GI foods [9]. However, some factors may affect the GI of food such as the types of carbohydrate, nutrients contents (for example, protein and lipid content), processing techniques, fiber composition, cooking methods, and respondent condition [10].

Moreover, high anthocyanin content of this instant rice may offer benefits on diabetes management and prevention, such as enhancing glycemic control, reduce inflammation and oxidative stress [11]. We suggest combining this instant black rice with other foods that have a low GI and are rich in fiber, vitamins, minerals, such as vegetables. Thus, this instant black rice can offer benefits for diabetes management and claimed as a healthy instant product. However, this research uses a small number of replications to analyze the nutritional quality of instant black rice products that may have affected the generalizability of the findings. Future studies with a larger number of instant black rice are needed to confirm these results.

4 Conclusion

In conclusion, instant Cempo Ireng soaked in 7% sodium citrate at 50°C has a highest anthocyanin content with moderate GI of 60. This product has the potential as a healthy instant product for preventing diabetes mellitus based on its slower impact on blood sugar

levels compared to high GI foods. Further research with a larger number of replications needs to be carried on the effect of different temperatures and soaking method on black rice quality. Furthermore, research about the glycemic index of instant black rice using larger number of respondents will give a chance in a better precision finding.

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