Comparative study on resistant starch, amilose content and glycaemic index after precooked process in white rice

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Comparative study on resistant starch, amilose content and glycaemic index after precooked process in white rice

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Abstract. Rice is a staple food and regarded as a useful carbohydrate source. In general rice is high in glycaemic index (GI) and low colonic fermentation. People are aware of the alterations in blood glucose levels or glycaemic index after consuming rice. Resistant starch (RS) and amylose content play an important role in controlling GI. GI and RS content have been established as important indicators of starch digestibility. The aim of this study was to determine the precooked process with hydrothermal (boiling at 80ºC, 10 minutes) and cooling process with low temperature (4ºC, 1 h) to increase potential content of RS and decrease of glycaemic index of white rice. There were two stages of this research, 1) preparation of white rice with precooked process; 2) analysis of precooked white rice characteristics (resistant starch, amylose content, and estimated glycaemic index). The result of analysis on precooked white rice showed an increased RS content (1.11%) and white rice (0.99%), but the difference was not statistically significant. The amylose content increased significantly after precooked process in white rice (24.70%) compared with white rice (20.89%). Estimated glycaemic index (EGI) decreased after precooked proses (65.63%) but not significant as compared to white rice (66.47%). From the present study it was concluded that precooked process had no significant impact on increasing RS and decreasing EGI of white rice. This may be due to the relatively short cooling time (1hour) in 4°C.

1. Introduction

Rice is a major source of carbohydrates consumed by people in the world and in Asia. In Indonesia, people tend to choose white rice as the main source of carbohydrate with average consumption level according to Indonesian Statistical Bureau is 1,631 kg/capita/week [1]. The main macronutrient content in rice is carbohydrate while dietary fiber is less, leading to a high glycaemic index. Excessive levels of white rice consumption and unhealthy lifestyle will increase risk of Diabetes mellitus (DM). The results of previous studies showed that increasing consumption of white rice was associated with increasing risk of type-2 diabetes [2]. The increased risk was associated with a white rice glycaemic index of 69.96 [3]. A high glycaemic index has been shown to increase the risk of type 2 DM of Japanese men [4]. Therefore, consumption of white rice may increase the risk of type 2 diabetes mellitus associated with the white rice glycaemic index [5, 6]. A high portion of white rice consumption significantly effected relative risk of type 2 diabetes mellitus by 1.11 [7]. In other studies it was shown that consumption of white rice more than 1 serving per day was positively correlated with blood pressure, triglycerides, and fasting blood glucose, and negatively correlated with HDL cholesterol [8].

Modification of the components of rice to reduce the glycaemic index can be done by applying of several processing methods. One of them is by precooking process which is associated with heating and cooling. These processes are expected to change the nutrient content in rice, especially in resistant starch (RS) content. This can be explained as a result of temperature changes which are then influences the structure of the rice starch leading to an increased RS content. In the process of heating, gelatinization occurs which can increase solubility and starch digestibility. However, the process of heating and cooling back can lead to the formation of insoluble retrogradation starch [9]. This fact underlies an idea to conduct a research on the comparison of starch resistant content, amylose levels, and glycaemic index of white rice after precooked process. The precooked process was conducted by heating and cooling, and was expected to increase the RS content in white rice.

2. Materials and Methods

The research was conducted at Pusat Studi Pangan dan Gizi (PSPG) laboratory, Laboratory of Pathology, Faculty of Veterinary Medicine, and Laboratory of Food Chemistry and Biochemistry, Faculty of Agricultural Technology, Universitas Gadjah Mada.

2.1. Materials

The material used in this research was white rice of IR 64 variety which is produced by Balai Benih Barongan, Bantul, Yogyakarta. The chemicals for analysis and some enzymes such as α-amylase, pepsin, pancreatin and amyloglucidase as well as glucose kit (GOD-PAP).

2.2. Precooking process

Precooking process was intended to increase the content of resistant starch. The precooking process was carried out by heating the rice at 80°C, then continued by cooling at 4°C. The process of retrogradation (recrystallization) of the starch could lead to the formation of type III resistant starch (RS) [10].

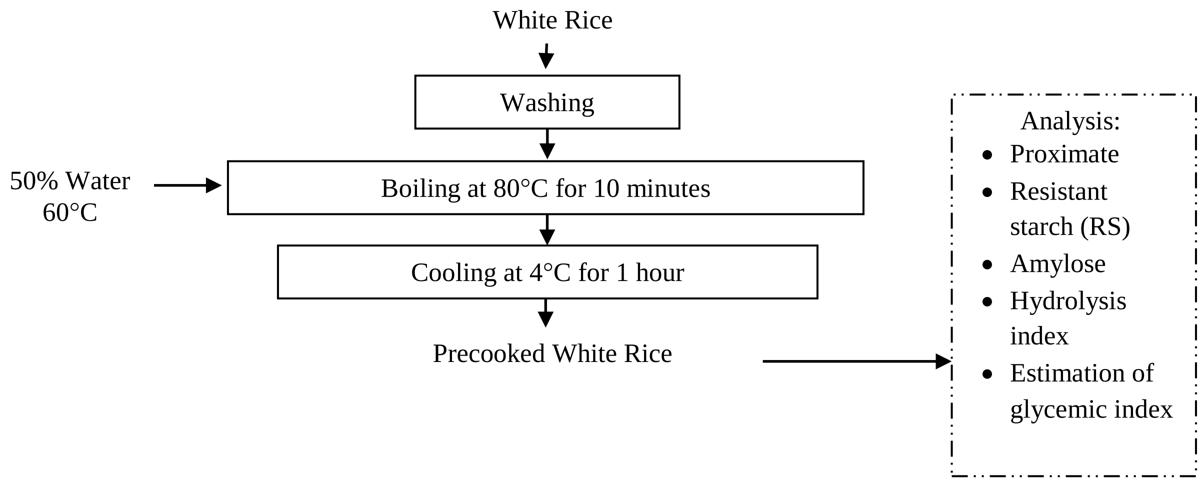

Figure 1. Flow chart of precooked rice processing

2.3. Analysis of precooked white rice

Characterization of the precooked rice include proximate analysis, amylose content, food fiber content, resistant starch content, hydrolysis index, and glycaemic index estimation. Proximate analysis [11] included water and ash content by thermogravimetric method, protein by using micro-Kjeldahl, fat by Soxhlet extraction method, and carbohydrates were calculated by difference [12]. Amylose analysis [10], analysis of dietary fiber [13], starch digestibility analysis, and resistant starch analysis using enzymatic methods (GOD FS) [14], and total starch analysis, hydrolysis index and estimated IG [15].

2.4. Data analysis

The experimental design used in this study was Completely Randomized Design (RAL). The data analysed by using one-way variance analysis (ANOVA). If a significant difference was found then continued with the Duncan Multiple Range Test (DMRT) using SPSS version 17 with 5% confidence interval.

3. Results and Discussion

3.1. Proximate analysis

The chemical composition in precooked white rice is presented in Table 1.

Table 1. Characteristics of precooked white rice.

Component	Precooked white rice (%db)
Ash	0.27 ± 0.02
Fat	0.40 ± 0.04
Protein	9.02 ± 0.55
Carbohydrate by difference	79.90 ± 0.21
Fibers	6.91 ± 0.23

Data is presented in the form of mean ± standard deviation

The chemical composition of precooked white rice was closed to previous studies [3]. Protein content (9.02%) was slightly lower when compared with white rice without precooked processing (10.83%). The fat content (0.40%) was slightly lower as compared to that of white rice with the same variety of 0.56%.

3.2. Amylose and resistant starch levels of white rice precooked

Amylose content (24.70%) increased compared with that in white rice (20.89%). The value of amylose content was in line with that reported by previous studies [16] with the same white rice varieties (24.59%). One-way ANOVA analysis on amylose levels between treatment groups showed significant difference between WR and PWR. RS content increased after the precooked treatment. The RS levels in PWR were 1.11% and thus increased slightly after precooked treatment as compared to WR (0.99%) but no significant difference was found. Amylose and RS content in both raw and precooked rice are presented in Table 2.

Table 2. Amylose and RS content of white rice precooked.

Ingredients	Amylose (%)	RS (%)
White Rice (WR)	20.89 ± 2.40^{a}	0.99 ± 0.11^{a}
Precooked White Rice (PWR)	24.70 ± 0.44^{b}	1.11 ± 0.01^{ab}

Different superscript notations in the same column showed significantly different ($p < 0.05$) using the ANOVA assay and Duncan's follow-up test. Data presented ± standard deviation

Precooking process of rice gives a change effect on the characteristics of a substance such as starch in rice. The results of the present study showed an increase of amylose and RS levels of precooked rice. The heating treatment then continued by cooling turns the starch into an undigested fraction (resistant starch). RS and amylose levels increased after precooked processing, compared with raw rice (results is presented in Table 2). This is in line with the results of previous research reported that process involves heating and cooling modified the starch resistance. Gelatinization process occurs when processing involves heat and can increase solubility and starch digestibility but it can also decrease the content of resistant starch in the material. However, when the heating process followed by re-cooling can lead to the formation of insoluble retrogradation starch [9]. Hydrothermal treatment followed by storage under low temperature (4°C) conditions can increase the formation of resistant starch as a result of recrystallization of amylose and amylopectin structure in rice, more common in amylose [17]. However in the present study, RS level in rice given precooked treatment did not show any significant difference as compared to raw rice. The results of this study are not in line with the other studies aiming to increase RS content such as a 16.8% increase of RS in sukun were reported after boiling process and continued with cooling [18]. The content of the RS that was not significantly different after the precooked process was probably due to a shorter cooling time of the precooking process.

3.3. Calculated Hydrolysis Index (CHI) testing and Estimated Glycaemic Index(EGI) in vitro method

The results of Calculated Hydrolysis Index (CHI) and Estimated Glycaemic Index (EGI) testing between raw and precooked rice is shown in Table 3.

Table 3. Calculated Hydrolisis Index (CHI) and Estimated Glycaemic Index (EGI).

Material	CHI	EGI
White Rice (WR)	48.75 ± 1.54[a]	66.47 ± 0.85[a]
Precooked White Rice (PWR)	47.03 ± 1.21[a]	65.53 ± 0.66[a]

Data presented as mean ± standard deviation. Different letters indicates significantly different (p <0.05) between treatments.

Table 3 shows the degree of hydrolysis (calculated hydrolysis index : CHI) and and the estimated glycaemic index: EGI) in white rice raw and after precooking treatment. Test results showed that CHI and EGI decreased after precooked treatment. The EGI in PWR (65.53) was lower as compared to WR (66.47) but not statistically significant. Precooking treatment involved heating and drying causing a decrease in glycaemic index from 69.96 to 51.99 [3]. The precooked process performed on white rice seems to decrease CHI and EGI, but did not differ significantly. The starch retrogradation in rice processing can decrease glycaemic index and starch digestibility [19]. The insignificant changes in CHI and EGI may well associate with RS levels which did not increase significantly either. The retrogradation process may be maximized at 4ºC by increasing storage time up to 24 hours as reported by other studies [19, 20].

4. Conclusion

Precooked treatment of white rice by heating then continued by cooling at 4ºC for 1 hour did not increase RS content and did not decrease estimation of glycaemic index. Future studies may have to increase storing time in low temperature to facilitate intensive retrogradation in white rice to increase RS content and reduce its digestibility.

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