Influence of pandan leaf extract and fortificants addition and cooling duration to cooking quality, preference level, and glycemic index of brown parboiled rice fortified with chromium and magnesium

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Abstract. The number of diabetics in Indonesia continues to increase. Therefore it is necessary to provide rice as a staple food that has a low glycemic index. It was also reported that diabetics had deficiencies of chromium and magnesium. Brown rice and parboiled rice are known to be low in the glycemic index, although it seems less preferred by consumers. Pandan leaf extract is known as an ingredient for strengthening flavor, and cooling is believed to be able to increase resistant starch and reduce the glycemic index. This study aimed to evaluate the effect of the addition of pandan leaf extract (PE) and fortificants in parboiling steps and cooling duration on cooking quality, preference level, and glycemic index of brown parboiled rice which was fortified with Cr and Mg. This study was carried out in a completely randomized design with two treatment factors. The first factor was the method to add PE and fortificants, namely: (1) addition of PE, Cr and Mg at the soaking (65 °C); (2) addition of Cr and Mg at soaking of 65 °C and adding pandan extract at boiling of 100 °C; (3) addition of PE, Cr, and Mg at soaking (65 °C) and followed by the addition of PE at boiling 100° C, and (4) addition of PE, Cr, and Mg at boiling (100 °C). The second factor was the cooling duration of 2 °C for 0, 12, 24, 36 hours. The method to add PE and fortificants and cooling time affects the cooking quality (water uptake ratio, elongation, and solid loss), but does not affect cooking time, and alkali spreading value. The addition of PE and fortificants (PE + Cr + Mg -65 °C, & PE-100 °C) for 36 hours of cooling time resulted in brown parboiled rice with a glycemic index of 40.39 (< 55 = low) and was slightly favored by panelists. The rice produced has cooking time of 43 minutes, alkali spreading value of 2, water uptake ratio of 3.10 g/g, elongation 1.21 mm/mm, and solid loss of 1.87 g/100 g.

1. Introduction
The number of people with diabetes mellitus in Indonesia continues to increase from year to year. Reported by the International Diabetes Federation, the estimated number of people with diabetes in Indonesia in 2017 reached 6.7% of the total population [1]. Therefore, efforts need to be made to provide food sources, especially rice, as a staple food, which is suitable for them, namely rice, which has a low glycemic index (GI).
It has been reported that brown rice [2, 3] and parboiled rice [4, 5, 6] have a low GI than white rice or milled rice. Brown rice [7, 8, 9] and parboiled rice [10, 11] can reduce the risk of type 2 diabetes mellitus. However, both types of rice are less preferred by consumers. Efforts that can be done to increase the level of preference by consumers is to add pandan leaf extract during the parboiling process. Pandan leaf extract has been known as a cooking spice for aroma enhancers and is known to be antihyperglycemic [12].

Two essential stages in the parboiling process that affect the quality of parboiled rice are soaking and steaming or boiling of grain. Soaking is intended to hydrate water into the grain until the water content reaches around 30% while steaming or boiling is intended for the gelatinization of rice starch. It has been reported that the addition of 3% pandan extract to chromium fortified rice coating [13] can increase the level of preference [13].

Diabetics, in addition to having high blood sugar levels (more than > 125 mg/dL when fasting), also experience deficiencies in chromium [14] and magnesium [15]. The deficiency of these two minerals can stimulate the ongoing increase in blood sugar. Therefore, it is necessary to add these pandan extracts and minerals in the development of rice for diabetics, namely fortified pre-fortified Cr and Mg rice and enriched with pandan leaf extract so that the rice is fulfilled by both minerals and can be favored by consumers. Previous research has shown that soaking grain with CrCl$_3$ of 7.47 mg/L in the parboiling process can produce fortified Cr parboiled rice of 0.56 mg/kg [16]. Meanwhile, coating Mg fortification of 1660 mg/kg of rice of magnesium can increase Mg by 1114–1451 mg/kg fortified rice [17].

Furthermore, to obtain rice with a low GI, the grain cooling process can be carried out. Cooling can increase resistant starch (RS) and reduce GI rice. Cooling of cooked starch is known to cause starch retrogradation, which in turn will increase the content of resistant starch. The grain from the Ciherang variety which was carried out by the parboiling process with the soaking stage at 65 °C for 2.5 hours and steaming for 25 minutes and continued cooling at 0 °C for 6 hours had resistant starch at 8.27–8.89% [18]. The mean of resistant starch levels from cereals (rice, wheat, and barley) 1.86% (dry weight) increased to 3.25% after three cycles of heating/cooling [19]. Starch retrogradation occurs in rice (Bengal and Cypress varieties) during storage at 96 hours at -13 and 3 °C, but not at 36 °C [20]. The cooling of white rice for 24 hours at 4 °C increases the resistance of starch, and after rice feeding, it gives a lower GI response compared to freshly cooked white rice [21].

Therefore, this study aimed to evaluate the effect of the method of adding pandan leaf extract and fortificants (Cr and Mg) carried out on soaking and/or boiling grain during the parboiling process, and the duration of cooling on cooking quality, level of preference and IG of the rice.

2. Materials and methods

2.1. Materials
The research used Ciherang rice (medium level of amylose) certified as Ciherang rice seeds obtained from an agriculture shop in Sleman, Yogyakarta, Indonesia. Pandan leaves (Pandanus amaryllifolius Roxb.) were used as natural herbal aroma enhancers. Chromium chloride (Sigma-Aldrich) was the source of Cr and magnesium acetate (Sigma-Aldrich) was the source of Mg. Other chemicals and reagents were an analytical grade (Sigma-Aldrich).

2.2. Preparation of the pandan leaf extract
Five hundred grams of pandan leaves were finely cut into 2 cm long slivers, then pulverized and soaked for extraction in 5 L of water. The solution was filtered using plain calico, and the 10% pandan extract or filtrate yielded was stored in a refrigerator at 4 °C.

2.3. Production of pandan extract–Cr and Mg fortified-parboiled rice
Production of chromium and magnesium fortified–parboiled rice was prepared using the method that has been used before [13] which had been modified. Five kilograms of Ciherang unhulled rice was
washed three times, twice with well water and finally with aqua dest. The good rice (which sank) and the empty hulls (which floated) were separated during the washing then drained. The use of 10% pandan extract, Cr (4 mg chromium chloride/L) and Mg (9 g magnesium acetate/L) fortificants was conducted as follows: (1) Method 1 - pandan leaf extract and Cr and Mg fortificants were added to the soaking mixture at 65 °C for 2.5 h; (2) method 2 - Cr and Mg was added to the soaking mixture (65 °C for 2.5 h) followed by pandan leaf extract while boiling the rice (100 °C for 20 minutes); (3) method 3 - pandan leaf extract and Cr and Mg fortificants were added to the soaking mixture (65 °C for 2.5 h), followed by the addition of pandan leaf extract (second) while boiling the rice (100 °C for 20 minutes); and (4) method 4 - the rice was soaked in aqua dest, then pandan leaf extract, Cr and Mg fortificants were added in the boiling stage (100 °C for 20 minutes). The rice from each of the methods was drained and cooled at 2 °C for 0, 12, 24 and 36 h, then dried in a cabinet dryer at 50 °C until the water content reached 11–12%. The dried rice was then de-hulled one time without polishing to produce brown parboiled rice fortified with chromium, magnesium, and pandan extract.

2.4. Cooking quality properties
Cooking quality properties of brown parboiled rice fortified with chromium, magnesium, and pandan extract, which include cooking time, alkali spreading value, elongation ratio, water uptake ratio, and solid loss were determined. The five characteristics of cooking quality are determined as has been done in previous research [22].

2.5. Preference level test
The preference level test used the hedonic method on 20 semi-trained panelists. The panelists were asked to assess different attributes, including the quality of taste, aroma, color, texture, adhesiveness, and overall acceptability of the parboiled rice fortified with chromium, magnesium, and pandan extract. The 6-point scale ranged from 1-6 and was calibrated thus: 1 = like very much, 2 = like, 3 = like slightly, 4 = dislike slightly, 5 = dislike, 6 = dislike extremely.

2.6. Determination of gi
A GI test was performed on 16 healthy (non-diabetic) volunteers. Following an overnight fast (10 h), each volunteer was asked to consume brown parboiled rice fortified with chromium, magnesium and pandan extract that contained 50 g glucose from 16 types of the rice derived from each treatment. Two hours afterward, blood samples were taken every 30 minutes to measure the level of glucose (at 30, 60, 90, and 120 minutes) [18]. Three volunteers tested each rice sample with a food reference (control) of 50 g glucose.

2.7. Data analysis
The analysis was conducted in a completely randomized design with four treatments of addition methods (method of 1, 2, 3, and 4) and cooling duration (0, 12, 24, and 36 h). The data obtained were done to a one-way analysis of variance (ANOVA) with a 95% confidence interval. Any significant difference in each treatment was followed by a Duncan Multiple Range Test. The total treatment combination was 16 treatments with three replicates.

3. Results and discussion

3.1. Alkali spreading value (ASV)
The brown parboiled rice produced from this study included a group of rice with high gelatinization temperature (> 74 °C) because all combinations of addition method of the pandan leaf extract with cooling time resulted in ASV of 2. At temperatures higher than 74 °C, the rice will experience 90% swelling of rice starch granules in hot water as indicated by loss crystal structure and birefringence. The gelatinization temperature of starch is grouped into several types, namely high, medium, and low gelatinization temperatures. The gelatinization temperature is high if the temperature is > 74 °C,
medium if it ranges between 70–74 °C and low if < 55–69 °C [23]. ASV is related to the amount of GT. Low GT (<= 70 °C has ASV = 6–7), medium GT = 70–74 °C has ASV = 3–5), and high GT >= 74 °C (ASV = 2) [24]. ASV, which shows high GT, and vice versa, high ASV shows low GT. The results of previous studies indicated that chromium fortified rice has 3–5 ASV [17]. Thus the treatment of fortification with Cr and Mg and the addition of pandan extract could increase the temperature of the gelatinization. It can be caused by the interaction between phenol compounds from pandan extract) and rice starch to form complex compounds that affect the degree of starch retrogradation [25], which in turn affects the hardness of rice produced. It is this hardness that allows the need for higher gelatinization temperatures. It has been reported that ASV of six fine grain rice varieties (Superfast, Basmati 4488, Khaszar, Basmati PNR, Badshabhog, and BRRI dhan 28) ranged from 3.0–3.9 [26]. The information signifies ASV besides being influenced by the method of post grain harvesting, also by the type or variety of rice.

3.2. Cooking time

The cooking time test results for brown parboiled rice fortified with chromium and magnesium with the addition of pandan leaf extract and duration of cooling are presented in table 1.

| Addition method of pandan extract and fortificants | Cooling duration (hours) |
|--------------------------------------------------|--------------------------|
|                                                   | 0 | 12 | 24 | 36 |
| 1: PE + Cr + Mg–65 °C.                           | 43 | 46 | 46 | 45 |
| 2: Cr + Mg–65 °C & PE–100 °C.                    | 43 | 47 | 45 | 44 |
| 3: PE + Cr + Mg–65 °C & PE–100 °C.               | 43 | 46 | 43 | 43 |
| 4: PE + Cr + Mg–100 °C.                          | 43 | 45 | 45 | 45 |

*Values are not significantly different at the 5% level (P < 0.05).*

Table 1 showed that the addition of pandan leaf extract and cooling time in fortified brown parboiled rice did not affect (P > 0.05) the cooking time of the brown parboiled rice produced. The cooking time value of the brown parboiled rice ranges from 43–47 minutes. It indicated that brown parboiled rice requires a relatively long cooking time compared to the cooking time of parboiled rice (white) fortified with chromium (23–25 minutes) [17]. The presence of cooling treatment (2 °C for 36 hours) and moderate amylose content (Ciherang rice) allowed the retrogradation of starch to occur. Retrogradation or reassociation or recrystallization of amylose will take place quickly, while the recrystallization of amylopectin will take place slowly. The starch retrogradation level and the newly formed crystals are influenced by time and temperature of storage, source of starch, and presence of other molecules in the system [27]. The retrogradation of starch can increase resistant starch. Retrogradation that occurs in amylose is irreversible at temperatures less than 100 °C [29] because amylose crystals melt at temperatures above 100 °C. The occurrence of the retrogradation of starch allows longer cooking times. This situation is in line with the ASV results, which showed a value of 2 or have a high gelatinization temperature (> 74 °C). Rice with high gelatinization temperature required longer cooking times.

Besides that, because brown parboiled rice still has layers of pericarp, aleurone, embryo, and endosperm, the rice requires a longer cooking time. Meanwhile, from the results of other studies, it was reported that cooking time decreased significantly with increasing immersion temperature from 40 °C to 50 °C and 60 °C (p < 0.05) respectively at 14.59–14.53 and 14.33 minutes, and for brown rice for 18 minutes [21]. The shorter the cooking time, the better in terms of fuel consumption and energy for cooking rice.
3.3. Water uptake ratio

The water uptake ratio test results water of brown parboiled rice fortified with Cr and Mg of various methods of adding pandan leaf extract and duration of cooling are presented in table 2.

Table 2. Water uptake ratio (g/g) of brown parboiled rice fortified with Cr and Mg of various methods of adding pandan leaf extract and duration of cooling.

| Addition method of pandan extract fortificants | Cooling duration (hours) |
|-----------------------------------------------|--------------------------|
|                                             | 0            | 12       | 24       | 36       |
| 1: PE + Cr + Mg–65 °C.                       | 4.14a        | 3.49a    | 3.10a    | 3.14a    |
| 2: Cr + Mg–65 °C & PE–100 °C.                | 2.84b        | 3.34b    | 3.54j    | 3.54j    |
| 3: PE + Cr + Mg–65 °C & PE–100 °C.           | 2.79a        | 2.87c    | 3.95m    | 3.26k    |
| 4: PE + Cr + Mg–100 °C.                      | 3.64l        | 3.61l    | 3.61k    | 3.02k    |

The numbers followed by different letter notation indicate significant difference at the 5% level (P < 0.05).

Table 2 showed that the addition of pandan leaf extract and cooling time in fortified brown parboiled rice significantly affected (P > 0.05) the water uptake ratio of the brown parboiled rice produced. The method or method of adding pandan leaf extract significantly affected the water uptake ratio, and the highest value of 4.14 (g/g) was achieved in method 1 without cooling, and the lowest value of 2.79 (g/g) produced from method 3 without cooling. There was a trend that the addition of pandan extract two times (methods 2 and 3) had a low water uptake capacity ratio, although after cooling it has increased. Conversely, the addition of 1 pandan extract (methods 1 and 4) had a high water uptake ratio, then decreased during cooling. While the results of previous studies revealed a water uptake ratio of Cr fortified parboiled rice of 2.60–3.06 (g/g) [17], and chromium fortified parboiled rice coated with herbal extracts of 4.05–4.51 (g/g) [13]. Other authors report the value of the water uptake ratio of Ofada rice samples ranging from 1.74–2.11% [32], some local and imported rice varieties in Penang Malaysia ranged from 2.33 to 3.95% [33].

Differences in the value of the water uptake ratio can be caused by processing or removing grain after harvesting, rice varieties or varieties which include starch, amylose, amylopectin, amylose ratio with amylopectin, resistant starch, and non-starch compounds, such as fats and proteins, and compounds and compounds that interact with starch with polyphenols and minerals. The results of the study have shown that the water absorption of regular corn starch is always lower than Amioca (waxy corn starch), higher than Hylon VII (high amylose corn starch), and Amioca always has the highest water uptake [29]. Amylose starch content is around 1–2% for Amioca, 21–24% for regular corn starch, and 63% for Hylon VII. The inverse correlation between water uptake and amylose content leads to water absorption will decrease when the amylose content increases. The same result was also reported by another author [30]. The ability to absorb water by starch is influenced by the levels of amylose and gelatinized starch, retrograded starch, cross-linked starch, reported as follows, in descending order: waxy corn starch > pregelatinized corn starch > corn starch > retrograded corn starch > 50% high amylose corn starch > 70% high amylose corn starch > 70% high amylose corn starch > linked corn starch [31].

3.4. Elongation ratio

The elongation ratio test was used to measure the elongation of brown parboiled rice produced before and after rice cooking. The elongation of rice is one of the quality attributes of cooking quality because it will affect its appearance. The appropriate elongation ratio will improve its appearance. The test results on the elongation ratio of brown parboiled rice fortified with Cr and Mg of various methods of adding pandan leaf extract and duration of cooling are presented in table 3.

Based on table 3, it can be seen that the addition of pandan extract and cooling time to fortified brown parboiled rice affected the elongation ratio of the produced parboiled rice. The highest elongation ratio is 1.22 mm/mm, and the lowest is 1.02 mm/mm. The treatment of the addition of pandan leaf extract
one time (method 1 and 2) resulted in a relatively high elongation ratio, but decreased during cooling, whereas in the method of adding pandan leaf extract two times, the elongation ratio increased for 24 hours cooling 2 °C, then decreased again significantly after 36 hours of cooling (1.08 mm/mm). The elongation ratio has a positive correlation with the water uptake ratio. Rice elongation is affected by the ratio of length (l) / breadth (b) and amylose content and has a positive correlation between them [34]. The results of other studies reported that the ratio of the elongation of Ofada rice (Oryza sativa L.) ranged from 1.24–1.75 [33] and Cr fortified-parboiled rice coated with chromium with various herbal extracts ranging from 1.53–1.87 [13].

Table 3. Elongation of brown parboiled rice fortified with Cr and Mg of various methods of adding pandan leaf extract and duration of cooling.

| Addition method of pandan extract and fortificants | Cooling duration (hours) |
|---------------------------------------------------|--------------------------|
| 1: PE + Cr + Mg–65 °C                            | 0  | 12  | 24  | 36  |
| 2: Cr + Mg–65 °C & PE–100 °C.                    | 1.15<sup>def</sup> | 1.11<sup>de</sup> | 1.19<sup>fgh</sup> | 1.08<sup>bc</sup> |
| 3: PE + Cr + Mg–65 °C & PE–100 °C.               | 1.14<sup>de</sup> | 1.11<sup>de</sup> | 1.19<sup>fgh</sup> | 1.08<sup>bc</sup> |
| 4: PE + Cr + Mg–100 °C.                          | 1.16<sup>efg</sup> | 1.14<sup>de</sup> | 1.14<sup>de</sup> | 1.06<sup>ab</sup> |

The numbers followed by different letter notation indicate significant difference at the 5% level (P < 0.05).

3.5. Solid loss

Solid loss is one of the quality attributes associated with how much solids the rice is released during rice cooking. The test results on the solid loss of brown parboiled rice with the addition of pandan leaf extract and the duration of cooling are presented in table 4.

Table 4. Solid loss of brown parboiled rice fortified Cr and Mg of various methods of adding pandan leaf extract and duration of cooling.

| Addition method of pandan extract and fortificants | Cooling duration (hours) |
|---------------------------------------------------|--------------------------|
| 1: PE + Cr + Mg–65 °C                            | 0  | 12  | 24  | 36  |
| 2: Cr + Mg–65 °C & PE–100 °C.                    | 1.27<sup>ab</sup> | 1.52<sup>ab</sup> | 1.56<sup>ab</sup> | 1.60<sup>abcd</sup> |
| 3: PE + Cr + Mg–65 °C & PE–100 °C.               | 1.54<sup>abc</sup> | 1.78<sup>abcd</sup> | 1.20<sup>a</sup> | 1.28<sup>ab</sup> |
| 4: PE + Cr + Mg–100 °C.                          | 1.72<sup>abcd</sup> | 1.79<sup>abcd</sup> | 1.80<sup>abcd</sup> | 1.81<sup>abcd</sup> |

The numbers followed by different letter notation indicate significant difference at the 5% level (P < 0.05).

Based on table 4, it appears that the method of adding pandan leaf extract significantly affected (P < 0.05) value of the solid loss, while the cooling time in the same method for the addition of pandan leaf extract, Cr and Mg did not affect solid loss from fortified brown parboiled rice which produced. The value of rice solid loss ranges from 1.20–2.17%. The formation of complex compounds from the interaction of starch with polyphenol compounds from pandan leaf extract can cause low dissolved solids. Solid loss generated from fortified parboiled rice ranges from 4.22–5.82% [17], while the value of the solid loss of some local and imported varieties of rice in Penang Malaysia ranges from 3.17–6.43% [33].

3.6. Level of preference

The parameters tested to determine the preference level of panelists on brown rice parboiled rice fortified with Cr, Mg, and pandan leaf extract include aroma, color, texture, taste, stickiness, and overall. The preference test results can be seen in table 5.
Based on table 5 it is known that the method of adding pandan leaf extract, Cr, and Mg and cooling time did not affect the level of preference of panelists for attributes of aroma quality, texture, taste, and stickiness, but affected the color parameters and overall preference level. This response can be caused by panelists or Indonesian people who prefer white and fluffed milled rice, and are not familiar or not used to consuming brown rice and parboiled rice. From table 5, it appeared that the panelists gave a slightly like rating (3) for the attributes of aroma, taste and stickiness, and a little dislike (4) for texture. Meanwhile, for the color attribute and the overall preference level, its were somewhat preferred to be somewhat disliked. It is due to parboiled rice, which is not sticky, and brown rice is known to be the brown color, which is less attractive and has a strong bran aroma. Brown rice is produced by stripping the husk from dry grain so that it still contains many layers of pericarp, aleurone, embryo, and endosperm. The dark color of brown rice is caused by the bran layer and is rich in vitamins such as thiamine, niacin, pyridoxine, and minerals such as manganese, phosphorus, and iron [34]. In general, all combinations of treatments from the method of adding pandan leaf extract and duration of cooling were considered rather preferred, except the method two without cooling and method 3 with a duration of 12 hours cooling was considered rather disliked by the panelists. Although the overall level of preference was not significantly different, then the measured glycemic value of the index was from treatment which produced the smallest overall level score (3.05 and 3.15), namely method 3 with 36 hours cooling time and method one without cooling.

**Table 5.** Level of preference for brown parboiled rice fortified Cr and Mg of various methods of adding pandan leaf extract and duration of fortified cooling.

| Addition method of pandan extract and fortificants | Cooling time (hour) | Aroma (*) | Color | Texture (*) | Taste (*) | Stickiness (*) | Overall |
|-------------------------------------------------|---------------------|-----------|-------|-------------|-----------|---------------|---------|
| Cr + Mg + EP-65°C | 0                   | 2.90      | 3.20  | 3.85        | 3.15      | 3.00          | 3.15    |
| & EP-100°C       | 12                  | 3.20      | 2.25  | 4.25        | 3.55      | 2.70          | 3.50    |
|                  | 24                  | 3.20      | 3.85  | 4.05        | 3.15      | 2.95          | 3.45    |
|                  | 36                  | 3.45      | 3.70  | 4.15        | 3.65      | 3.10          | 3.75    |
| Cr + Mg + EP-65°C | 0                   | 4.85      | 3.10  | 3.60        | 3.80      | 2.80          | 4.15    |
| & EP-100°C       | 12                  | 3.20      | 2.85  | 3.80        | 3.25      | 2.70          | 3.55ab  |
|                  | 24                  | 2.95      | 2.85  | 3.55        | 3.00      | 2.95          | 3.45bc  |
|                  | 36                  | 3.35      | 3.25  | 3.85        | 3.25      | 3.10          | 3.55bc  |
| Cr + Mg + EP-65°C | 0                   | 3.30      | 3.75  | 4.15        | 3.35      | 2.65          | 3.75bc  |
| & EP-100°C       | 12                  | 3.20      | 3.30  | 4.30        | 3.30      | 3.10          | 3.90bc  |
|                  | 24                  | 3.25      | 3.20  | 4.10        | 3.40      | 2.85          | 3.70bc  |
|                  | 36                  | 3.05      | 3.05  | 3.55        | 3.00      | 2.85          | 3.05bc  |
| Cr + Mg + EP-100°C | 0                   | 3.35      | 3.65  | 4.00        | 3.40      | 2.75          | 3.70ab  |
|                  | 12                  | 3.15      | 3.20  | 3.95        | 3.15      | 2.65          | 3.35bc  |
|                  | 24                  | 3.20      | 3.10  | 3.60        | 3.10      | 2.85          | 3.40bc  |
|                  | 36                  | 3.25      | 3.40  | 3.80        | 3.25      | 2.85          | 3.25ab  |

The numbers followed by different letter notation indicate significant difference at the 5% level (P < 0.05). The smaller the number shows the more preferred the sample. 1 = very like, 2 = like, = like slightly, 4 = dislike slightly, 5 = dislike, 6 = very dislike. *: shows the same notation or not significant differences

### 3.7. Glycemic index

The results of the analysis of blood sugar from healthy volunteers during fasting up to 120 minutes after consuming brown parboiled rice were graphed, where the Y or ordinate axis as blood sugar levels (mg/dL) and X-axis as the time of blood sampling (minutes). The glycemic index value was calculated based on the area under the curve of each voluntary blood sugar response from 3 rice samples, namely brown parboiled rice from the treatment method 3 (PE + Cr + Mg–65 °C & PE–100 °C) with 36 hours
cooling time, method 1 (PE + Cr + Mg–65 °C), and parboiled rice as a comparison, while controls are used glucose. Based on the picture, it can be seen that the blood glucose response in respondents from brown parboiled rice from both method 1 and 3 was slower than parboiled rice. The results of the calculation of the glycemic index in brown parboiled rice with the addition of pandan leaf extract and duration of cooling are presented in table 6.

| Type of rice                                | Glycemic index |
|---------------------------------------------|----------------|
| Parboiled rice                              | 45.03          |
| Brown parboiled rice (Cr + Mg + PE-65°C, without cooling) | 42.70          |
| Brown parboiled rice (Cr + Mg + EP-65°C & PE-100°C, 36 h of cooling time) | 40.39          |

From table 6 it can be seen that IG parboiled rice used as a comparison has the value IG 45.03, IG brown parboiled rice from method one without cooling and method 3 with cooling 36 hours in a row of 42.37 and 40.39. Besides that treatment of method 3 with 36 hours of cooling time can produce 9 ug Chromium/100 g and 49 mg magnesium/100 g parboiled brown rice (data not shown). Brown rice is not only rich in basic nutritional components (carbohydrates, fats, and proteins) but also contains more bioactive components. Brown rice, which contains bran and embryos, has a nutritional value higher than white rice because bran and embryos contain many nutritional and bioactive components including dietary fiber, functional lipids, amino acids, vitamins, phytosterols, phenolic compounds, gamma-aminobutyric acid and minerals [35].

Regarding the potential antioxidant properties, it has been investigated that the relatively high total phenolic content (TPC), total anthocyanin content (TAC) and antioxidant activity (AOA) were contained in 10% polished rice (non-polishing brown rice) than polished rice 100%. Compared with white basmati, red basmati contains higher amounts of TPC, TAC, and AOA, which also negatively correlate with GI [36]. Substituting parboiled brown rice for white rice for three months, showed a potential benefit for glycemia among people with metabolic syndrome and among those who had elevated body mass index [37]. Brown rice is the result of the removal of the husk (without polishing), so when compared to the same cooking time, brown rice always produces lower postprandial glucose and insulin responses than white rice [38]. The glycemic and insulinenic responses of the brown rice diet and brown with legumes are not significantly different. Consumption of brown rice as a substitute for white rice can help reduce 24-hour glucose and fasting insulin responses among overweight Asian Indians [2].

While it was reported that the parboiling process increased the amylose content of rice from 15.44–26.32% to 19.35–27.25% and dietary fiber content from 4.68–7.57% to 8.19–10.27%, but reduced starch digestibility in vitro from 62.31 to 78.63% to 35.52–49.74%, the parboiled process also reduces rice GIs from 54.43 to 97.29 to 44.22–76.32 [6]. The same thing was stated, parboiling generally reduces the GI from most of the rice varieties [5]. The GI test results from rice processed parboiling and without parboiling showed parboiled rice for Nadu Bg 352 had GI 40, much lower than GI rice (raw) Bg 360 Samba (66) and Basmati At 405 (73) [4]. The results of other studies also showed that low IG from parboiling rice, namely Cr-PR rice coated with 6% pandan leaf extract produced a GI of 37 [18] and parboiled rice which was processed soaking, and followed by steaming on a pressure of 1.5 kg/cm 2 for 20 minutes resulted in GI of Pusa Basmati 1121 rice by 47.04 [39]. The glycemic index of non-parboiled (NP) rice was 55, mildly traditionally parboiled (TP) 46, and severely pressure parboiled (PP) 39, and IG from PP rice was significantly lower than NP (P < 0.05). The insulin response was similar for three rice meals, all of which were lower than white bread (P < 0.001). All rice test foods contained low glycemic in type 2 diabetes subjects. There was no TP effect on the glycemic index, whereas PP reduced the glycemic index to almost 30% compared to NP [11].

Besides the influence of the processing factor (parboiling), the low GI rice produced could also be caused by the high polyphenol compound from the extract of pandan leaves that enters the rice. The
results of extracting pandan leaves (Pandanus amaryllifolius Roxb.) with distilled water or ethanol could inhibit the α-glucosidase enzyme and induce insulin production in rat pancreatic cells (RINm 5F) [12].

4. Conclusions
The addition of pandan leaf extract and cooking time affected the firm quality (water uptake ratio, elongation, and solid loss) but did not affect cooking time and alkali spreading value of fortified brown parboiled rice Cr and Mg. The rice that was favored by the panelists was rice fortified brown parboiled rice Cr and Mg with Method 1 - pandan leaf extract and Cr and Mg. and Cr and Mg fortificants were added to the soaking mixture (65 °C for 2.5 h), followed by the addition and leaf extract (second) while boiling the rice (100 °C for 20 minutes) with 36 hours of cooling. The quality properties of the fish produced by chromium and magnesium fortified brown parboiled rice with method 3 treatment and 36 hour cooling have 43 minutes cooking time, alkali spreading value 2 (high gelatination temperature), water uptake ratio 3.10%, elongation 1.21, solid loss 1.87%, level of preference with a score of 3.05 or somewhat preferred, and GI of 40.39.

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