Physicochemical and Functional Characteristics of Roasted Sticky Rice Flour (Tapuang Bareh Randang) in Various Methods

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Abstract. White sticky rice in West Sumatra is traditionally processed into bareh randang (roasted rice cake) and is one of the traditional snacks of this province. Beras rendang (bareh randang) is made by roasting white sticky rice and add coconut sugar. Roasted rice flour has the potential as a functional food because of some previous cereal studies proving that cereal roasting can maintain nutritional value and improve its functional properties. This study aimed to determine the effect of roasting methods (traditionally and oven) and roasting temperatures (140, 160, and 180°C) on the physicochemical and functional characteristics of tapuang bareh randang. The study was conducted by comparing tapuang bareh randang that is traditionally made and by using an oven at various roasting temperatures. The results of this research showed that Traditional roasting (TR) and roasting using an oven with a temperature of 180°C (SC) is roasting sticky rice flour with the highest amylose content. Traditional Roasting (TR) has the highest total phenol content compared to other roasting. Traditional roasting (TR) and roasting oven 160°C (SB) has resulted in significant color changes in flour. Traditional roasting (TR) and roasting using an oven with a temperature of 180°C (SC) increases the amylose content and has the potential to reduce the glycemic index of tapuang bareh randang.

Keywords: Antioxidant, Roasted Flour, Roasting Temperature, Starch, Tapuang Bareh Randang

1. Introduction

Cereals are one of the main sources of carbohydrates that most widely used in human food, which used as a staple food. Some examples of cereals are rice, white sticky rice, black sticky rice, barley, wheat, and others. The naming of rice and sticky rice in Indonesia is base on the adhesiveness caused by the content of amylopectin more than amylose in the starch. White sticky rice in West Sumatra cooks traditionally into Roasted Rice Flour (tapuang bareh randang), which is then made into another food product called Bareh Randang. Tapuang Bareh Randang is flour obtained from the grinding of white sticky rice that has been roasted on a cauldron into yellowish without the addition of other ingredients. This flour is then added to coconut sugar and printed into a traditional food of West Sumatra known as "Bareh Randang"[1].
Roasting can be done traditionally, roasting with oven, microwave, Infra-red, roaster, and others. In a previous study [1], it showed that roasting white sticky rice from several “Bareh Randang” production centers in Payakumbuh City, reduced water content, protein content, fat content and amylopectin content but instead increased amylose, carbohydrate and ash content compared without roasting. Several recent studies have shown that the treatment of rice or other cereals can improve their functional properties. The research showed that the roasting red rice increases the total phenol, flavonoids and antioxidant capacity of red rice compared to red rice without processing, pressure cooking and microwave [2]. The another research showed that roasting barley flour by microwaving increase the DPPH antioxidant activity, anti-cancer ability, ability to inhibit free radicals, inhibit DNA damage compared to barley flour without roasting [3].

Roasted barley given to mice can increase their antioxidant ability, the activity of the enzyme Super Oxide Dismutase (SOD), and the enzyme Glutathione Peroxidase (GSH), as well as reduce levels of Malonaldehyde (MDA) of the liver and brain of the rat [4]. Besides, roasted wheat increase total phenol and antioxidant activity compared to unroasted wheat [5].

Various benefits that have studied make roasted rice flour a potential to be researched and developed. However, in West Sumatra, tapuang bareh randang (roasted sticky rice flour) is only processed into “bareh randang” snack. That is due to limited information regarding the physical and chemical properties of flour, starch gelatinization profile, proper processing method, and health benefits of the rendang rice flour.

There is no previous research on tapuang bareh randang, which focuses on the effect of different roasted techniques and temperature on two types of white sticky rice flour on its physicochemical and functional characteristics. Therefore, research is needed regarding the physical, chemical, and amylose-amylopectin ratio. Besides, there is research on the functional properties of tapuang bareh randang to show the health benefits of tapuang bareh randang.

The aim of this study was evaluate changes on physicochemical and functional characteristics of two types of white sticky rice due to differences in roasting techniques and temperature of the roasting.

2. Methods

2.1 Materials
The sticky rice used in the study was selected according to the type of sticky rice used at the production center in Payakumbuh, West Sumatra (CA and KM). After roasting, roasted rice flour is prepared by grinding in a flour mill with a particle size of 0.12 - 0.150 μm.

2.2 Methods
The sticky rice roasting method is carried out with two techniques, namely traditional and oven, with three roasting temperatures (140, 160, and 180 ° C). The tests conducted were 1) Starch Analysis (SNI 01-2892-1992), 2) Amylose Content (Apriyantono et al., 1998), and Amylopectin, 3) Analysis of total phenols and antioxidants, and 4) Measurement of flour color (ColorQuest XE, Hunterlab, USA).

2.3 Statistical Analysis
All experiments were conducted in triplicates, and the data were expressed as mean ± deviation standard. One-way analysis of variance (ANOVA) and Duncan's multiple range tests was carried out to determine significant differences (p <0.05) between the means by Statistical Packages for Social Sciences (SPSS version 12.0).

3. Results and Discussion

3.1. Starch Content
Starch is the main energy storage reserve of carbohydrates which plays an important role as functional
3. Ingredients in the food and non-food industries [6]. Following are the results of the analysis of starch content from KM and CK flour.

### Table 1. Starch Content of CA Flour

| Treatments | Starch Content (%) |
|------------|--------------------|
| CAKO       | 67.87 ± 0.30       |
| CASA       | 71.67 ± 0.28       |
| CATR       | 74.24 ± 0.80       |
| CASB       | 74.54 ± 0.53       |
| CASC       | 75.28 ± 0.35       |

*aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

### Table 2. Starch Content of KM Flour

| Treatments | Starch Content (%) ± SD |
|------------|-------------------------|
| KMSA       | 7.12 ± 0.10             |
| KBSC       | 8.67 ± 0.01             |
| KMSB       | 8.91 ± 0.88             |
| KMTR       | 9.55 ± 0.27             |
| KMKO       | 12.23 ± 0.32            |

*aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

3.2. Amylose and Amylopectin content

The Physicochemical Properties of carbohydrate source ingredients can be seen based on the ratio of amylose and amylopectin starch. In this study, the determination of the amylose content was carried out on white sticky rice flour, and the processed product was tapuang bareh randang. Following are the results of the ratio of amylose and amylopectin of starch from KM and CK flour.

### Table 3. Amylose and Amylopectin Ratio of KM Flour

| Perlakuan | Amylose content (%) | Amylopectin content (%) |
|-----------|---------------------|-------------------------|
| CAKO      | 5.33 ± 0.34         | 94.62 ± 0.21            |
| CASB      | 6.88 ± 0.13         | 93.12 ± 0.32            |
| CASA      | 7.47 ± 0.69         | 92.53 ± 0.69            |
| CATR      | 7.82 ± 0.33         | 92.18 ± 0.13            |
| CASC      | 9.11 ± 0.21         | 90.89 ± 0.39            |

*aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

### Table 4. Amylose and Amylopectin Ratio of KM Flour

| Perlakuan | Kadar Amilosa (%) | Amylopectin content (%) |
|-----------|------------------|-------------------------|
| KMSB      | 4.57 ± 0.19      | 95.43 ± 0.24            |
| KMKO      | 5.02 ± 0.29      | 94.98 ± 0.82            |
| KMSA      | 6.76 ± 0.29      | 93.23 ± 0.28            |
| KMSC      | 7.12 ± 0.82      | 92.89 ± 0.28            |
| KMTR      | 8.19 ± 0.24      | 91.81 ± 0.19            |

*aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.
A Comparison of amylose and amylopectin levels of a carbohydrate source material shows the physicochemical properties of the material. Based on the data obtained, it can be seen that the Traditional roasting (TR) and roasting using an oven with a temperature of 180 (SC) is rendang rice flour with the highest amylose content. This showed a significant increase in amylose levels (P < 0.05) and decreased amylopectin levels. This is consistent with the results of previous research, which showed the degradation of amylopectin molecules to short-chain amylose molecules due to heating [7]. In addition, due to heating-cooling treatment showed the level of arrowroot starch amylopectin fraction decreased, and the amylose fraction increased [8].

3.3. Polifenol content
Following are the results of the polifenol content of KM and CK flour.

| Perlakuan | Total Polifenol (mg GAE/g) ± SD |
|-----------|---------------------------------|
| CASC      | 34.62 ± 4.53                   |
| CAKO      | 40.87 ± 15.95                  |
| CASB      | 57.89 ± 2.80                   |
| CASA      | 78.36 ± 1.73                   |
| CATR      | 128.58 ± 1.30                  |

aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

The sample with the highest phenolic content was CATR 128.58 ± 1.30 mg GAE/g, while the lowest was CASC 34.62 ± 4.53 mg GAE/g. Roasted at 180° C for eight minutes with an oven can decerase the total phenol content of sticky rice. Total content of phenol tapuang bareh randang with traditional methods have high total phenol, while roasting oven reduces total phenol content. The results confirm previous research; an increase in phenolic compounds after thermal treatment, showing an increase in TPC during roasting due to an increase in the extraction power of phenolics bound by the thermal degradation of cellular constituents [9].

| Perlakuan | Total Polifenol (mg GAE/g) ± SD |
|-----------|---------------------------------|
| KBSC      | 7.68 ± 3.23                     |
| KMSB      | 16.29 ± 3.88                    |
| KMSA      | 18.67 ± 1.73                    |
| KMTR      | 86.77 ± 0.65                    |
| KMKO      | 94.31 ± 0.65                    |

aResults are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

The highest total phenolic, namely KMKO treatment, was 94.31 ± 0.65 mg GAE / g, followed by traditional 86.67 ± 0.65 mg GAE / g, and the lowest in KBSC treatment was 7.68 ± 3.32 mg GAE / g. In this study, it was shown that the traditional roasting treatment had a high phenol content of high rendang rice flour (p <0.05). The breakdown of cellular constituents results in the release of bound phenolic acids and related Maillard reactions further contributing to this process [10].

3.4. Color of Flour (L, a, b)
The color of the samples was determined in triplicate using the equipment ColorQuest XE (Hunter Lab, ColorQuest, USA), use the CIE a*b* system. This system determines the L*, a*, and b* values, where L* represents lightness with 0 for black and 00 for white; a* represents the opposition between green and red colors ranging from positive (green) to negative (red) values, and b* is the yellow/blue
opposition also ranging from positive (yellow) negative (blues) values. In the CIE L*a*b* color space, a*, and b* values exhibit minima and maxima values that depend on L* value.

### Table 7. L, a, b color value Content of CA Flour

| Perlakuan | Nilai L ± SD | Nilai a  | Nilai b  |
|-----------|--------------|----------|----------|
| CAKO      | 85.48 ± 0.22c| -0.34 ± 0.08 e | 6.77 ± 0.02 b |
| CASC      | 87.28 ± 0.10d| -0.53 ± 0.01 b | 6.91 ± 0.03 b |
| CASB      | 87.45 ± 0.09d| -0.50 ± 0.01 c | 6.70 ± 0.32 b |
| CASA      | 87.67 ± 0.18d| -0.48 ± 0.01 c | 6.75 ± 0.08 b |
| CATR      | 89.42 ± 0.32d| -0.37 ± 0.01 d | 6.71 ± 0.48 b |

*Results are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

The roasting significantly increases the L* value; this showed the significant color turns darker, especially in traditional processing, in one type of sticky rice 160ºC has resulted in a significant change. The a* value obtained indicates a redder change in temperature of 180ºC compared to traditional kicking. This shows a higher Maillard reaction. This is expected to increase the aroma of flour. While the value of b*, which shows blue-green is not significantly different. Many reactions take place during roasting that may affect the color. The color observed in extruded products might be due to caramelization or the Maillard reaction [11]. Lysine and other amino acids present in the raw material probably react with the reducing sugars, favored by the processing conditions, which lead to the darkening of the extruded products [12].

### Table 8. L, a, b color value Content of KM Flour

| Perlakuan | Nilai L ± SD | Nilai a  | Nilai b  |
|-----------|--------------|----------|----------|
| KMKO      | 86.70 ± 0.11b| -0.48 ± 0.00 d | 8.19 ± 0.19 c |
| KMSC      | 87.72 ± 0.07c| -0.59 ± 0.00 b | 7.74 ± 0.32 c |
| KMSA      | 87.73 ± 0.39c| -0.56 ± 0.01 c | 7.67 ± 0.03 c |
| KMTR      | 88.54 ± 0.28d| -0.26 ± 0.02 c | 7.93 ± 0.35 cd |
| KMSB      | 88.56 ± 0.43d| -0.55 ± 0.00 c | 7.09 ± 0.03b |

*Results are mean of five treatments ± SD. Values with same letters (b, c, d, e within column) are not significantly different at p < 0.05.

4. Conclusions

Traditional roasting (TR) and roasting using an oven with a temperature of 180ºC (SC) is roasting sticky rice flour with the highest amylose content. Traditional Roasting (TR) has the highest total phenol content compared to other roasting. Traditional roasting (TR) and roasting oven 160ºC (SB) has resulted in significant color changes in flour.

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