Differences in preferences, water content, and dietary fibre of jackfruit seed crackers enriched with red beetroot (*Beta vulgaris*)

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Abstract. Increasing public attractiveness to crackers can be done by diversifying non-protein cracker products. Jackfruit seeds have potential as an additive for crackers because it contains high starch and nutrients, such as dietary fibre. The purpose of this research is to determine the differences in preference for experimental crackers as well as water content and total dietary fibre. Mean analysis was used to determine level of public preference and Kruskal-Wallis test is used to determine differences in the level of preference. To determine the difference in water content and dietary fibre, used non-homogeneous sample t-test. Preference test showed steamed and boiled-steamed jackfruit seeds treatment got an average score of 5.6 and 5.7 criteria favoured by panellist, treatment for boiled jackfruit seeds with average score of 5.4 criteria less favoured by panellist. The nutritional analysis with low water content and high dietary fibre in steamed treatment with average water content of 2.40% and total dietary fibre of 9.21. Kruskal-Wallis test showed P-value of 0.000 <0.05, meaning that there was a difference treatment of jackfruit seeds on texture preference aspect. Non-homogeneous sample t-test analysis showed P-value <0.05, meaning that there was a difference in water content and dietary fibre.

1. Introduction

*Kerupuk* or crackers are a type of dry food made from ingredients that contain quite a lot of starch, one of the main raw materials is tapioca flour and the additional ingredients are fish meat, crushed shrimp, salt, vetsin (monosodium glutamate or MSG), and sometimes dye [1]. The development of science and technology demands a more diverse variety of ingredients for making crackers, taking into account appearance and nutritional value, in order to increase the public's interest to alternative crackers available, through cracker products diversification. One of the ingredients being used in crackers making is jengkol. *Jengkol* is containing 4.06% fibres, when it is wet the starch content in *jengkol* is 11.56% (wb), while it is dry the starch content in *jengkol* is 34.83 % (db.), best crackers result obtained from X1 treatment with the proportion of tapioca and jengkol puree of 90%:10%, having white bone colour, not having a typical jengkol aroma, not having a jengkol flavour, and being crunchy [2]. Besides *jengkol*, *garut* crackers processed by steaming, pressure cooking, and boiling deemed to be the most preferred *garut* crackers, in which steamed *garut* crackers sample receive average score of 6.34, pressure cooked *garut* crackers sample receive average score of 6.31, and boiled *garut* crackers sample receive average score of 4.86 [3]. Results of these studies indicates that addition of other food ingredients in making crackers can be done as an effort to diversify non-protein cracker products that have the potential and feasibility to be accepted by consumers.
Jackfruit (Artocarpus heterophyllus) is a species of tree of the family Moraceae Mulberry [4]. Shoots jackfruit seeds are contained in jackfruit, oval to flat. Jackfruit seeds weigh about 10 to 15% of the total weight of the fruit and have a high content of carbohydrates and protein, dietary fibre, vitamins and minerals [5]. The most common benefits of jackfruit seeds include preventing wrinkle skin, anti-cancer properties, and its fibre and prebiotic content helps the digestive process [6]. Observing its advantages, 100 g of fresh jackfruit seeds contain high enough nutrients including crude protein (6.6 g), fat (0.4 g), carbohydrates (38.4 g), fibre (1.5 g), ash (1.25–1.50 g), and moisture (51.6–57.77 g) [7].

Jackfruit seeds have high starch content so that they can be alternative source of starch which contains soft and hard jackfruit seed starch content of 92.8% and 94.5%, respectively [8]. Jackfruit seeds are being used as ingredient in making stick crackers because they have high starch content and most of the jackfruit waste is being thrown away and not being utilized [9]. The results of the preference test for the effect of substitution of jackfruit seed flour on the organoleptic and chemical properties of crackers did not show a significant difference from the substitution of jackfruit seed flour of 5%, 10% and 15%, all of which were quite favoured by the panelist [10]. Boiled jackfruit seeds and boiled durian seeds added to crackers mixture performed as an organoleptic test on colour, taste, aroma and texture of jackfruit seed crackers and durian seed crackers, which were favoured by panelist [11]. Jackfruit seeds are one of the underutilized ingredients that have the potential to be used as variations in making crackers as well as jengkol.

Jackfruit seeds contain sap, have hard texture and slippery. Therefore, it is essential to process the jackfruit seeds before adding them to the cracker mixture. Food processing is applied to convert raw materials into food or food into other forms so that they can be consumed by humans or processed by the food processing industry [12]. Hence, in this study different treatment to jackfruit seeds is applied.

In order to increase the appearance and nutritional content, red beet puree is added to the cracker mixture to produce a natural red colour from the betalain pigment contained in red beets. Red beet is a traditional vegetable and is popular in various parts of the world as a vegetable rich in fibre and sugar and has a moderate calorific value, besides that it also has bioactive compounds such as betalains, carotenoids and other nutrient source of food ingredients [13]. Betalain is a natural pigment with antioxidant and biological activity which is currently used as a natural food colourant [14]. The chemical contents of red beet are 20 IU of vitamin A, 0.02 mg of thiamine, 0.05 mg of riboflavin, 0.4 mg of niacin, 10 mg of vitamin C, 27 mg of calcium, 1.0 mg of iron, 43 mg of phosphorus, 87.4 g of fibres, 1 g of fat, 9.6 g of carbohydrates, 1.6 g of protein, and 42 kcal/100g of calories [15]. Crackers added with 50% beet juice, water use is replaced entirely by beet juice, resulting in a redder cracker colour [16]. In this study, jackfruit seeds were steamed, boiled, and boiled-steamed before being mixed into the cracker mixture and added with red beet puree.

The objectives of the study are 1) To find out the differences in people's preferences to jackfruit seed crackers with the addition of red beet with the treatment of steamed, boiled and boiled-steamed jackfruit seeds. 2) To find out the difference in water content and total dietary fibre of jackfruit seed crackers with the addition of red beet with the treatment of steamed, boiled, and boiled-steamed jackfruit seeds. 3) To find out the amount of water content and total dietary fibre content of jackfruit seed crackers with the addition of red beet with seed treatment steamed, boiled, and boiled-steamed jackfruit seeds.

2. Research Method
The object of this study is crackers made from jackfruit seeds with different treatments, namely steamed, boiled, boiled-steamed, and the addition of red beet puree in each treatment. This study uses three variables, namely the independent variable, the dependent variable, and the control variable. The independent variables in this study are the use of jackfruit seeds with different treatments, namely steamed, boiled, and boiled-steamed. The dependent variables used in this study are the level of preference for jackfruit seed crackers with the addition of red beet with different treatments of jackfruit seeds, namely steamed, boiled, and boiled-steamed, as well as water content and dietary fibre in experimental crackers. The control variables in this study are the quality of ingredients, the weighing of ingredients, the equipment used, the mixing of ingredients, the addition of red beets, the steaming of the
mixture, the crackers slicing process, the crackers drying process, temperature and time of the frying process, and the cooling time process.

The ingredients used in the making of jackfruit seed crackers with the addition of red beetroot are tapioca flour, jackfruit seeds, red beets, eggs, garlic, salt, and sugar. The tools used in the making of jackfruit seed crackers with the addition of red beet are basins, steamers, pots, pans, scoops, spatulas, tampah (winnowing basket), trays, measuring cups, digital scales, analogue thermometers, spoons, knives, cobek (mortar and pestle), blenders, stoves, and gas.

Crackers making process should follow certain steps, because it will affect the quality of crackers [17]. The process of making jackfruit seed crackers with the addition of red beets includes the preparation of tools, preparation of ingredients, processing of jackfruit seeds for 45 minutes with 1 litre of water (boiled-steamed treatment; 25 minutes boiled and 20 minutes steamed), and processing red beetroot steamed for 10 minutes added with 25% of water then mashed using a blender resulting red beet puree. Crackers dough in each sample is made by mixing 100 grams of tapioca flour, 50% pretreated jackfruit seeds for each sample, 75% red beet puree, 20% egg, 20% garlic, salt and sugar each as much as 4%. After mixing the dough, put them in a plastic with diameter of 5 cm with a length of 20 cm and steamed for 30 minutes and then rest them overnight until the dough are solid and chewy. The crackers dough is cut into 1-2 mm thickness, dried in the sun, and fried at 150ºC for 10 seconds.

The research approach method applied is experimental. The experimental design carried out in this study is single factor Completely Randomized Design (CRD). Completely Randomized Design (CRD) is variations generated by the treatment of one particular factor being experimented and other factors outside the treatment or environmental factors in the experimental unit conditioned to be homogeneous (homogeneous) and the placement of the treatment in experimental units is carried out completely random [18]. The data collection method uses sensory and objective assessment. The sensory assessment carried out is a preference test toward jackfruit seed crackers with the addition of red beet from the experiment in terms of colour, aroma, texture, and taste aspects. While the objective assessment is carried out by laboratory tests to determine the water content and total dietary fibre in the experimental jackfruit seed crackers with the addition of red beets from the experiment. Data analysis used is mean value analysis to determine the level of public preference. The Kruskal-Wallis test followed with the Mann-Whitney test is applied to determine the difference in the level of public preference for jackfruit seed crackers with the addition of red beet. In addition, laboratory test is applied to determine the water content using the drying oven method. Total dietary fibre was measured using the AOAC Method by adding up dietary fibre and higher molecular weights, including insoluble dietary fibre and soluble dietary fibre [19]. Inhomogeneous sample t-test is used to determine the differences of water content and fibre content in the experimental crackers.

### 3. Preference Test Result

#### 3.1. Mean Value analysis

Mean value analysis is carried out toward preference test results of jackfruit seed crackers with the addition of red beet to the aspects of colour, aroma, texture, and taste given to 80 untrained panellists. The results of the analysis toward the level of preference of crackers from the experiment can be seen in table 1 below.
Table 1. Results of mean value analysis

| Aspects         | Steamed jackfruit seeds | Boiled jackfruit seeds | Boiled-steamed jackfruit seeds |
|-----------------|-------------------------|------------------------|--------------------------------|
|                 | Value       | Criteria  | Value       | Criteria  | Value  | Criteria |
| Colour          | 5.9         | Favoured  | 5.9         | Favoured  | 6.0    | Favoured |
| Aroma           | 5.4         | Less favoured | 5.4      | Less favoured | 5.4    | Less favoured |
| Texture         | 5.5         | Favoured  | 4.7         | Less favoured | 5.6    | Favoured |
| Taste           | 5.8         | Favoured  | 5.7         | Favoured  | 5.8    | Favoured |

Table 1 shows that the three samples of jackfruit seed crackers with the addition of red beets in the colour aspect are similarly favoured with a score range of 5.9-6.0 and in the aroma aspect they are equally less favoured with a score of 5.4 each. In the aspect of the texture of jackfruit seed crackers with the addition of red beets, the treatment of steamed and boiled-steamed jackfruit seeds was equally favoured with a score of 5.5 and 5.6, for the treatment of boiled jackfruit seeds, the treatment was less favoured with a score of 4.7. In the aspect of taste of jackfruit seed crackers with the addition of red beets, the treatment of steamed and boiled-steamed jackfruit seeds was equally favoured with a score of 5.8 each, for the treatment of boiled jackfruit seeds favoured a score of 5.7. The level of public preference is presented in the following radar graph in Figure 1.

![Radar graph showing preference level of jackfruit seed crackers added with red beet.](image)

Figure 1. Preference level of jackfruit seed crackers added with red beet.

3.2. **Kruskal-Wallis Test**

3.2.1. **Colour.** The results of the Kruskal-Wallis test on the colour aspect of the experimental crackers can be seen in Table 2.

Table 2. Results of Kruskal-Wallis test on colour aspects

| Colour         | Kruskal-Wallis H | Df | Asymp. Sig. |
|----------------|-----------------|----|-------------|
| Colour         | 1.670           | 2  | .434        |
Based on Table 2, it can be seen that the significance of the colour aspect is 0.434 > 0.05, which means $H_a$ is rejected and $H_0$ is accepted, meaning that there is no difference in the level of preference on colour aspect of experimental crackers. The different treatments given to jackfruit seeds, namely steamed, boiled, and boiled-steamed, did not affect the level of colour preference for jackfruit seed crackers with the addition of red beet.

The jackfruit seed crackers with the addition of red beet in this study has a pink colour from the addition of red beet puree because of the betalain pigment content which then bound to jackfruit seed starch and tapioca flour. A boiled jackfruit seed produces crackers with a slightly lighter colour. It happens because the red beet puree is not completely absorbed by the starch granules in the boiled jackfruit seeds due to the presence of water that has infiltrated the jackfruit seeds. Crackers with the addition of 25% beet juice containing beet juice mixing with water resulting in less red crackers [16].

3.2.2. Aroma. The results of the Kruskal-Wallis test on aroma aspects can be seen in Table 3.

| Aroma | Kruskal-Wallis $H$ | Df | Asymp. Sig. |
|-------|-----------------|----|------------|
|       | .270            | 2  | .874       |

Based on Table 3, it can be seen that the significance of the aroma aspect is 0.874 > 0.05, which means $H_a$ is rejected and $H_0$ is accepted, meaning that there is no difference in the level of preference on aroma aspect of experimental crackers. The different treatments given to jackfruit seeds, namely steamed, boiled, and boiled-steamed, did not affect the level of preference for the aroma of jackfruit seed crackers with the addition of red beet.

The aroma produced by the jackfruit seed crackers with the addition of red beet, has less distinctive flavour of jackfruit seeds and red beet. There is no unpleasant aroma produced because the jackfruit seeds are treated first and in the making of red beet puree, a steaming process is carried out which eliminates the unpleasant aroma.

3.2.3. Texture. The results of the Kruskal-Wallis test on texture aspects can be seen in Table 4 below.

| Texture | Kruskal-Wallis $H$ | Df | Asymp. Sig. |
|---------|-----------------|----|------------|
|         | 23.145          | 2  | .000       |

Based on Table 4, it can be seen that the significance of the texture aspect is 0.000 < 0.05, which means $H_a$ is accepted and $H_0$ is rejected, meaning that there is a difference in the level of preference on texture aspect of the experimental crackers. Providing different treatments, namely steamed, boiled, and boiled-steamed toward jackfruit seeds, affected the level of texture preference for jackfruit seed crackers with the addition of red beet.

The texture of the jackfruit seed cracker with the addition of red beet is dry and crispy in the treatment of steamed and boiled-steamed jackfruit seeds, while the boiled treatment has a crispy texture but less dry. This is because the higher the water content in the crackers, resulting in less crunchy crackers. This is in line with the study stating that garut crackers with boiled garut resulting a slightly less crunchy texture. Due to its high level of water content, not all water can be evaporated during frying; causing cracker porosity to be reduced and therefore lowers the quality of the crackers, namely crispness [20].
3.2.4. Taste. The results of the Kruskal-Wallis test on taste aspects can be seen in Table 5.

| Taste | Kruskal-Wallis H | Df | Asymp. Sig. |
|-------|-----------------|----|-------------|
|       | 3.832           | 2  | .147        |

Based on Table 5, it can be seen that the significance value on the taste aspect is 0.147 > 0.05, then Hₐ is rejected and H₀ is accepted, meaning that there is no difference in the level of preference on the taste aspect of experimental crackers. Giving different treatments, namely steamed, boiled, and boiled-steamed jackfruit seeds did not affect the level of taste preference for jackfruit seed crackers with the addition of red beet.

Jackfruit seed crackers with the addition of red beet produce a savory and distinctive taste of jackfruit seeds and red beets. The savoury taste is produced from the addition of spices; garlic, sugar, and salt. The difference in processing technique did not contribute to the taste of the crackers [20]. Additional ingredients used to bring out better taste of crackers using ingredients that contain protein, fat, sweet and savoury flavours, and water to make cracker dough [1].

3.3. Mann-Whitney Test

The Mann-Whitney test was conducted to find out which sample groups were different. The Mann-Whitney test was carried out on the results of the preference test for the texture aspect of jackfruit seed crackers with the addition of red beets. The results of the Mann-Whitney test on the texture aspect can be seen in Table 6.

| Aspects | Pairing Samples       | P (Value) < 0.05 | Description |
|---------|-----------------------|------------------|-------------|
| Texture | Steamed and boiled    | 0.000            | Difference  |
|         | Steamed and boiled-steamed | 0.207          | No difference |
|         | Boiled and boiled-steamed | 0.000          | Difference  |

Based on Table 6, the level of preference for the texture aspect in the pair of steamed and boiled-steamed samples shows no difference indicated by a significance result of 0.20 > 0.05. Meanwhile, in the pair of steamed with boiled and boiled-steamed samples, there was a difference in the level of preference for the texture aspect, which was indicated by a significance result of 0.00 < 0.05.

4. Nutritional Analysis Result

The results of laboratory test on water content and total dietary fibre, carried out at the Chem-Mix Laboratory Bantul, Yogyakarta, are presented in Table 7.

4.1. Water Content

The analysis results of laboratory tests indicates that the water content contained in the fried crackers was reduced to around 1.05%-5.48%, this was due to the evaporated water content [1]. Based on the results of the analysis of water content on fried jackfruit seed crackers with the addition of red beet, the results show the 2.40% on steamed jackfruit seeds sample, 3.86% on boiled jackfruit seeds sample and 3.39% on boiled-steamed jackfruit seeds sample. The boiled jackfruit seed sample has a higher water content. This is because the high amylose content in jackfruit seeds has a higher ability to absorb water [21]. The three samples of jackfruit seed crackers with the addition of red beet with different treatments of jackfruit seeds shows similar results, which is around 1.0%-1.46%.
Table 7. Results of Laboratory Test on jackfruit seed crackers with addition of red beets

| Nutrients       | Repetition | Jackfruit Seed Crackers with Addition of Red Beets |          |          |
|-----------------|------------|--------------------------------------------------|----------|----------|
|                 |            | Steamed jackfruit seed | Boiled jackfruit seed | Boiled-steamed jackfruit seed |
| Water (%)       | 1          | 2.42 | 3.85 | 3.39 |
|                 | 2          | 2.39 | 3.87 | 3.40 |
|                 | Mean       | **2.40** | **3.86** | **3.39** |
| Insoluble       | 1          | 8.69 | 7.08 | 7.93 |
| Dietary Fibre   | 2          | 8.82 | 7.19 | 7.98 |
|                 | Mean       | **8.75** | **7.13** | **7.95** |
| Soluble         | 1          | 0.45 | 0.39 | 0.41 |
| Dietary Fibre   | 2          | 0.44 | 0.28 | 0.46 |
|                 | Mean       | **0.44** | **0.33** | **0.43** |
| Total Dietary Fibre (%) | 1  | 9.15 | 7.48 | 8.35 |
| Dietary Fibre   | 2          | 9.27 | 7.48 | 8.44 |
|                 | Mean       | **9.21** | **7.48** | **8.39** |

Table 8. Results of t-Test on moisture content of non-homogeneous sample

| Nutrients       | Pairing Samples | Equal variances not assumed | P-value < 0.05 | Description |
|-----------------|-----------------|-----------------------------|----------------|-------------|
| Water Content   | Steamed and boiled | Sig. (2 tailed) | Sig. (2 tailed/2) | 0.05 | Difference |
|                 | Steamed and boiled-steamed | 0.000 | 0.000 | 0.05 | Difference |
|                 | Boiled and boiled-steamed | 0.003 | 0.001 | 0.05 | Difference |

In table 8, the results of the non-homogeneous sample t-test explain that there are differences in the water content of each treatment as shown in p-value <0.05. According to SNI 8272:20016 regarding the quality of fish, shrimp, and mollusc crackers, the maximum moisture content of crackers is 12.0% [22]. Based on this quality, the water content of the three samples of jackfruit seed crackers with the addition of red beet is in accordance with Indonesian national standards.

4.2. Dietary Fibres

The results of the analysis on total content of dietary fibre content shows that the jackfruit seed crackers with the addition of red beet of steamed jackfruit seed samples has the highest dietary fibre content, namely 8.75% in insoluble dietary fibre and 0.44% in soluble dietary fibre, with the accumulation of total dietary fibre as much as 9.21%, 8.39% total dietary fibre content in the boiled-steamed jackfruit seed samples, and 7.48% total dietary fibre content in boiled jackfruit samples. The different treatments on three samples of jackfruit seed crackers with the addition of red beet do not have too much of a difference, which is around 0.82%-1.73%. This shows that there is no significant difference in total dietary fibre in each treatment.

Jackfruit seed crackers with the addition of red beetroot samples using boiled jackfruit seeds show the lowest total dietary fibre (TDF) content. This is because the boiling process can increase the levels of insoluble dietary fibre by 1.25%, and can also reduce levels of total dietary fibre by 3.8% and soluble...
dietary fibre by 5.05% [23]. Boiling process can cause water to slowly penetrate into the ingredients, and taking the juice out of the ingredients mixed with the boiling water [24].

Table 9. Results of t-Test on fibres of non-homogeneous sample

| Nutrients          | Pairing Samples                  | Equal variances not assumed | P-value < 0.05 | Description |
|-------------------|----------------------------------|----------------------------|----------------|-------------|
| Dietary Fibres    | Steamed and boiled               | 0.022                      | 0.05           | Difference  |
|                   | Steamed and boiled-steamed       | 0.011                      | 0.05           | Difference  |
|                   | Boiled and boiled-steamed       | 0.031                      | 0.05           | Difference  |

Table 9 describes the results of the non-homogeneous sample t-test explain that there are differences in the content of dietary fibre in each treatment as shown in p-value <0.05. According to the Regulation of the Head of BPOM Number 13 of 2016, in order to claim a product can be considered as a source of dietary fibre, the product should contain 3 g/100 g of dietary fibre or 3% in percentage [25]. In line with this regulation, the fibre content of the three samples of jackfruit seed crackers with the addition of red beet complies with BPOM regulations.

5. Conclusion

The level of people's preference on colour aspect shows that the three samples of jackfruit seed crackers with the addition of red beet have similar results with criteria of being favoured. From aroma aspect, the three samples of jackfruit seed crackers with the addition of red beet have the same results with criteria of being less favoured. In terms of texture, steamed and boiled-steamed samples were favoured by the public, while the boiled sample is less favoured by the public. In regards to taste aspect, the three samples of jackfruit seed crackers with the addition of red beet have almost the same results as being favoured.

Based on the results of the Kruskal-Wallis test, there are differences in the level of preference on texture aspect of the jackfruit seed crackers with the addition of red beet given different treatment toward the jackfruit seed samples. While in the aspect of colour, aroma, and taste there is no significant difference in the level of preference. The Mann-Whitney test indicates that there are differences in the level of preference for the texture aspect of the steamed jackfruit seed sample and the boiled jackfruit seed sample, and the boiled jackfruit seed treatment sample and the boiled-steamed jackfruit seed treatment sample. The results of the water content analysis show that the boiled jackfruit seed sample has the highest water content of 3.86%. Meanwhile, in the analysis of total dietary fibre, the steamed jackfruit seed sample has the highest total dietary fibre content, which is 9.21%. The results of the t-test of non-homogeneous samples on the water content and dietary fibre content show that there are differences in the water content and dietary fibre content of each experimental cracker sample.

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