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Steamed cake with okra flour substitution as an alternative to snack for a fibre source

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Abstract. The level of fibre consumption of the Indonesian population is 10.5 g of fibre per day, whereas WHO recommends consuming 25-30 g of dietary fibre per day. Efforts to increase consumption of dietary fibre by adding fibre to steamed cakes. The aim of this research is to examine steamed cake substituted by okra flour as an alternative snack for a source of dietary fibre. The research design was a non-factorial Completely Randomized Design (CRD), namely the proportion of wheat flour: okra flour (P). The treatments consisted of P1 = 60%: 40%, P2 = 55%: 45%, P3 = 50%: 50%, P4 = 45%: 55% and P5 = 40%: 60%. The results showed that the substitution of okra flour in wheat flour affects the total fibre content and power development. P3 treatment with a substitution of 50% okra flour is the best treatment. The best composition of steamed cake contains 7.38 grams of protein, 6.37 grams of fat, 37.87 grams of carbohydrates and 5.34 grams of dietary fibre per 100 grams. For daily dietary fibre needs from a snack, it is recommended to consume steamed cakes weighing 100 grams, which can provide 17.8% dietary fibre, 12.3% protein, 9.5% fat, 11.65% carbohydrates of the nutritional adequacy rate.

1. Introduction

The recommendation for fibre consumption per day according to WHO (World Health Organization) is 25-30 grams/ day, while the average Indonesian population consumes 10.5 grams of fibre / day. The adequate consumption of vegetables and fruit as a source of food fibre for Indonesians over 10 years of age is only fulfilled by 6.3% of Indonesia's population. Consumption of ⁶vegetables and fruit that is less indicates consumption of dietary fibre, which can cause degenerative ⁶diseases such as hypertension, coronary heart disease, hypercholesterolemia and obesity.

One of the efforts to increase fibre consumption is by processing vegetables into other processed foods that are more accepted by the community, namely steamed cake. The average consumption of traditional cakes in Indonesia has increased, to 1345 units /capita /year in 2017. Steamed cakes are made from ingredients that are high in fat but do not contain dietary fibre, thus requiring the addition of fibre sources from okra vegetables.

Okra is mucilaginous, which is high in soluble fibre. Okra contains a total fibre of 3.2 grams per 100 grams [7]. Powdered okra has increased levels of dietary fibre to 14.21 grams [1]. The mucus contained in okra is a long chain hydrocolloid polysaccharide with a high molecular weight, so that it has potential as an emulsifying, thickening and binding agent [2]. The physical properties of okra flour ² can form a gel will affect the texture or elasticity of food products [1]. The purpose of this study was to examine the steamed cake substituted by okra flour as a snack source of food fibre.

2. Material and methods

2.1. Materials

The materials used in this study were green okra from PT Mitra Tani 27 Jember which was processed into flour according to [3], high protein flour, egg white, vegetable oil, sugar and cake emulsifier.

2.2. Making steamed cake

Egg white, sugar and cake emulsifier beaten until white and fluffy. Then add the sifted flour and okra flour. Next, add vegetable oil and stir until evenly mixed. Put the cake batter on a baking sheet and do the steaming at 100°C for 15 minutes

2.3. Analyse the character of the steamed cake

The properties of the steamed cake analysed included levels of food fibre (gravimetric method), volume development (measuring the volume of steamed cake after baking compared to the volume before baking with the calculation of length x width x height), sensory analysis was carried out using the hedonic test and hedonic quality test, which analysed by 25 semi-trained panellists.

2.4. Statistic analysis

Statistical analysis was carried out on fibre content and development volume with a test using analysis of variance with a confidence level of $\alpha = 0.05$, and if there is a significant difference it will be continued with the Duncan test.

2.5. Determination of the best treatment

The best research treatment was analysed using the effective index method [4].

2.6. Analysis of Nutritional Composition

Nutritional composition analysis was performed using proximate analysis.

2.7. Determination of serving measurement

Determination of serving size is done to determine the portion size of the steamed cake for daily dietary fibre intake

3. Result and Discussion

3.1. Total fibre

The substitution of okra flour in wheat flour affects the amount of food fibre contained in steamed cakes. The results of the analysis of total fibre content are presented in Table 1. Total fibre content increases with increasing substitution of okra flour in the steamed cake formulation, because okra flour contains 14.21% fibre which is higher than wheat flour which only contains 2.7% fibre [1]

Dietary fibre can be divided into two types, namely soluble dietary fibre (SDF) and insoluble dietary fibre (IDF). SDF can be defined as dietary fibre that is soluble in warm or hot water. Meanwhile, IDF can be defined as food fibre that is insoluble in hot or cold water. IDF is the largest group of Total Dietary Fibre (TDF) in food, while SDF only occupies a similar amount in food. Okra is a type of vegetable that has mucilaginous properties or high levels of water soluble fibre [5].

3.2. Power of development

The highest development power, namely 90.52%, was produced from the P1 treatment with the substitution treatment of 40% okra flour and 60% wheat flour. The lowest expansion power was 22.82%, obtained from the substitution of 60% okra flour and 40% wheat flour. The results of measuring the development power of the steamed cake are presented in Table 1.

The development power of the steamed cake decreases when the okra flour used increases. This is because okra flour has high fibre. The high fibre content will cause the amount of gluten in the batter to

decrease. The high fibre content will cause the water content to be bound by the dough to be higher. Fibre absorbs water and water is trapped in the fibre network. In cake batter with high substitution of okra flour, the water that should bind to the gluten in the wheat flour instead binds to the fibre. This condition causes the formation and retention of CO₂ gas by gluten to be inhibited, as a result, the expansion power and elasticity of the steamed cake is decreasing [6].

Table 1 Effect of okra flour substitution on total fibre content and power development of steamed cake.

| Treatment | Total fibre (g) | <i>p</i> | Power development (%) | <i>p</i> |
|--------------------------------------|-------------------|----------|-----------------------|----------|
| P1 (60% wheat flour: 40% okra flour) | 4.16 ^a | 0.01 | 90.52 ^b | 0.01 |
| P2 (55% wheat flour: 45% okra flour) | 4.61 ^b | | 51.96 ^a | |
| P3 (50% wheat flour: 50% okra flour) | 5.34 ^c | | 40.76 ^a | |
| P4 (45% wheat flour: 55% okra flour) | 5.76 ^d | | 33.66 ^a | |
| P5 (40% wheat flour: 60% okra flour) | 6.26 ^e | | 22.82 ^a | |

3.3. Hedonic Quality Test

The hedonic quality test is used to assess the specific impression of the steamed cake. To assess the impression, a numerical scale of 1 to 5 is used. Specific impressions assessed include sweetness, after-taste bitter, unpleasant odour, tenderness, pore density and brownish colour.

3.3.1. Sweetness

The results of the hedonic quality test of the sweetness of the steamed cake is presented in Table 2. Scale 1 for "very weak", scale 2 for "weak", scale 3 for "slightly strong", scale 4 for "strong" and scale 5 for "very strong".

Table 2 Results of the hedonic quality assessment of the sweet taste of steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 0.8 | 24.8 | 36.8 | 33.6 | 4.0 | 100 |
| P2 | 0.0 | 29.6 | 53.6 | 12.8 | 4.0 | 100 |
| P3 | 11.2 | 32.8 | 23.2 | 28.8 | 4.0 | 100 |
| P4 | 0.0 | 24.8 | 45.6 | 29.6 | 0.0 | 100 |
| P5 | 8.0 | 15.2 | 43.2 | 33.6 | 0.0 | 100 |

Table 2 shows that the level of sweetness decreases in the substitution treatment for okra flour at 40%, 45%, and 50%, then the okra substitution increases again by 55% and 60%. The level of sweetness of the steamed cake is at a slightly strong to very strong level as indicated by the percentage of sweetness strength of 74.4% (P1) 70.4% (P2) 56.0% (P3), 75.2% (P4) and 76, 8% (P5).

The sweet taste of steamed okra flour substitution is influenced by the mucilage content of okra. Mucilage okra can be used as a thickener and sweetener in food [8]. In addition, okra also contains 1.2% sugar consisting of sucrose, glucose and fructose [7]

3.2. After Taste Bitter

The results of the hedonic quality test after taste of the bitter taste of steamed cakes is presented in Table 3. Scale 1 for "very weak", scale 2 for "weak", scale 3 for "slightly strong", scale 4 for "strong" and scale 5 for "very strong".

Table 3 Results of hedonic quality assessment after taste bitter steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 18.4 | 52.0 | 22.4 | 7.2 | 0.0 | 100 |
| P2 | 6.4 | 41.6 | 32.8 | 19.2 | 0.0 | 100 |
| P3 | 8.0 | 33.6 | 38.4 | 20.0 | 0.0 | 100 |
| P4 | 13.6 | 28.8 | 40.0 | 17.6 | 0.0 | 100 |
| P5 | 9.6 | 26.4 | 23.2 | 36.8 | 4.0 | 100 |

Table 3 shows that the bitter after-taste increases with the increasing substitution of okra flour. Based on the strength level of bitter after taste, from slightly strong to very strong, respectively starting from treatment P1, P2, P3, P4 and P5 with substitution of 40%, 45%, 50%, 55% and 60%.

The main source of bitter after taste is the product of the breakdown process of lipids and proteins. The bitter after taste can be caused by the hydrolysis of amino acids which occurs in the Maillard reaction during the process of making okra flour. Amino acids that can cause a bitter taste, such as lysine, arginine, proline, phenylalanine, and valine. Likewise, the phenolic compounds in okra can cause a bitter after-taste in steamed cake products that are substituted for okra flour.

3.3.3. Unpleasant Odour

The results of the hedonic quality test of the unpleasant aroma of okra on steamed cakes is presented in Table 4. Scale 1 for "very weak", scale 2 for "weak", scale 3 for "slightly strong", scale 4 for "strong" and scale 5 for "very strong".

Table 4 Results of the hedonic quality test of unpleasant odour steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 8.0 | 28.8 | 44.0 | 17.6 | 1.6 | 100 |
| P2 | 1.6 | 28.0 | 37.6 | 31.2 | 1.6 | 100 |
| P3 | 2.4 | 23.2 | 58.4 | 16.0 | 0.0 | 100 |
| P4 | 6.4 | 20.8 | 37.6 | 32.0 | 3.2 | 100 |
| P5 | 16.8 | 18.4 | 32.0 | 26.4 | 6.4 | 100 |

Table 4 shows that the unpleasant odour increases with the increasing substitution of okra flour. The percentage of unpleasant odour in steamed cakes is mostly in the range from slightly strong to very strong and less at very weak and weak. Based on the level of odour strength, P3 treatment (substitution of okra flour 50%) is the highest with a percentage of 74.4%.

The unpleasant odour in the steamed cake products is thought to be due to the content of unsaturated fatty acids such as oleic and linoleic acids in okra flour. Unsaturated fatty acids, especially linoleic, are catalysed by the enzyme lipoxygenase, which breaks down unsaturated fatty acid chains into smaller compounds, such as aldehyde compounds, ketones or alcohol which cause an unpleasant odour in okra flour [10].

3.3.4. Tenderness

The results of the hedonic quality test for tenderness on steamed cakes are shown in Table 5. Scale 1 for "not very soft", scale 2 for "not soft", scale 3 for "slightly soft", scale 4 for "soft" and scale 5 for "very soft".

Table 5 Hedonic quality test results of softness of steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|------|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 0.0 | 13.6 | 44.0 | 30.4 | 12.0 | 100 |
| P2 | 6.4 | 7.2 | 33.6 | 44.8 | 8.0 | 100 |
| P3 | 0.0 | 11.2 | 32.0 | 52.8 | 4.0 | 100 |
| P4 | 0.0 | 8.0 | 36.0 | 47.2 | 8.8 | 100 |
| P5 | 0.0 | 12.0 | 31.2 | 50.4 | 6.4 | 100 |

Table 5 shows that the level of tenderness was higher with the increase in substitution of okra flour. The percentage of tenderness in steamed cakes is mostly in the range from slightly soft to very soft and less at the level of not very soft and not soft. Based on the level of tenderness, P4 treatment (substitution of okra flour 55%) was the highest with a percentage of 92%.

Steamed cake tenderness is influenced by fibre content and expansion power. Increasing the fibre content causes the amount of water bound by the dough to be higher, thus making the cake dough more viscous or thickening and difficult to flow and inhibiting cake development. The mucus produced from okra fruit is a long chain hydrocolloid polysaccharide with a high molecular weight, so that the mucus of okra fruit has the potential as an emulsifying, thickening, and binding agent [2]. The role of hydrocolloids is very important in the manufacture of bakery products. Hydrocolloid types such as gum can increase the volume of development and the softness of the bread texture [11].

3.3.5. Pore Density

The results of the hedonic quality test of pore density on the steamed cake are shown in Table 6. Scale 1 for "very tenuous", scale 2 for "tenuous", scale 3 for "slightly dense", scale 4 for "tight" and scale 5 for "very tight".

Table 6. Hedonic quality test results pores desity of steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 0.8 | 25.6 | 39.2 | 34.4 | 0.0 | 100 |
| P2 | 1.6 | 15.2 | 37.6 | 39.2 | 6.4 | 100 |
| P3 | 4.0 | 16.8 | 40.8 | 38.4 | 0.0 | 100 |
| P4 | 0.0 | 16.0 | 40.8 | 42.4 | 0.8 | 100 |
| P5 | 0.0 | 20.0 | 48.0 | 28.8 | 3.2 | 100 |

Table 6 shows that the pore density of the cake is mostly in the range from slightly dense to very tight and less at very tenuous and tenuous. Based on the density level, P4 treatment (substitution of okra flour 55%) was the highest with a percentage of 84%. The tight or smooth pores of the steamed cake are formed because the air that enters the cake batter is dispersed in the form of fine bubbles. With more and more okra substitutions, the pores of the steamed cake become tighter because the batter is no longer able to withstand the gas generated during the steaming process. This is because okra flour does not contain materials that can withstand gas during development, air cannot be held and it comes out causing the pores to get tighter [12].

3.3.6. Brownish colour

The results of the hedonic quality test for the brownish colour of the steamed cake are presented in Table 7. Scale 1 for "very faded", scale 2 for "faded", scale 3 for "slightly sharp", scale 4 for "sharp" and scale 5 for "very sharp".

Table 7 Hedonic quality test results brownish colour of steamed cake

| Treatment | Hedonic quality scale (%) | | | | | Total (%) |
|-----------|---------------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 5.6 | 44.8 | 36.0 | 13.6 | 0.0 | 100 |
| P2 | 5.6 | 24.0 | 52.0 | 18.4 | 0.0 | 100 |
| P3 | 0.0 | 15.2 | 62.4 | 21.6 | 0.8 | 100 |
| P4 | 0.8 | 15.2 | 55.2 | 26.4 | 2.4 | 100 |
| P5 | 0.0 | 12.0 | 44.8 | 36.8 | 6.4 | 100 |

Table 7 shows that the brown colour is getting stronger with the increasing substitution of okra flour. The percentage of brown colour in the steamed cake is mostly in the range of slightly sharp to very sharp and a little bit of brown colour is very faded and faded. Based on the strength level of the brown colour from slightly sharp to very sharp, respectively starting from treatment P1, P2, P3, P4 and P5 with substitution of 40%, 45%, 50%, 55% and 60%. Basically okra has a green colour, but during the drying process it turns brown. The browning reaction that occurs when okra is dried and the activity of the polyphenol oxidase enzyme residue causes browning [13]. When okra flour is used in steamed cake batter it causes the steamed cake to turn brown.

3.4. Hedonic Test

The hedonic test was used to assess the panellist's preference for the taste, smell, texture and colour of the steamed cake with okra flour substitution. The scale used is a numerical scale of 1 to 5. Scale 1 for "dislike", scale 2 for "slightly dislike", scale 3 for "rather like", scale 4 for "like" and scale 5 for "really liked".

4.1. Taste

The hedonic test results on the taste of the steamed cake are presented in Table 8.

Table 8 Hedonic test results taste of steamed cake

| Treatment | Hedonic scale (%) | | | | | Total (%) |
|-----------|-------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 4.0 | 18.4 | 51.2 | 26.4 | 0.0 | 100 |
| P2 | 2.4 | 14.4 | 44.8 | 36.0 | 2.4 | 100 |
| P3 | 3.2 | 20.0 | 62.4 | 14.4 | 0.0 | 100 |
| P4 | 0.8 | 30.4 | 44.8 | 24.0 | 0.0 | 100 |
| P5 | 4.8 | 21.6 | 55.2 | 17.6 | 0.8 | 100 |

Table 8 shows that the preference for the steamed cake colour is represented by rather like to really like, and the level of dislike for steamed cake is represented by dislike to slightly dislike. Based on the level of preference, P2 treatment (substitution of okra flour 45%) had the highest preference level with a total preference percentage of 83.2%. The characteristic taste of steamed cake in P2 treatment was characterized by sweetness "slightly strong to very strong" 70.4% and "very weak to weak" 29.6% (Table 2). In addition, P2 treatment was characterized by after taste bitter "slightly strong to very strong" 52 % and "very weak to weak" 48 % (Table 3).

4.2. Odour

The hedonic test results on the texture of the steamed cake are presented in Table 9.

Table 9 Hedonic test results odour of steamed cake

| Treatment | Hedonic scale (%) | | | | | Total (%) |
|-----------|-------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 11.2 | 14.4 | 49.6 | 24.8 | 0.0 | 100 |
| P2 | 8.8 | 17.6 | 46.4 | 24.8 | 2.4 | 100 |
| P3 | 4.8 | 27.2 | 56.0 | 9.6 | 2.4 | 100 |
| P4 | 8.0 | 24.8 | 50.4 | 16.8 | 0.0 | 100 |
| P5 | 8.8 | 29.6 | 44.8 | 15.2 | 1.6 | 100 |

Table 9 shows that the preference for the steamed cake odour is represented by rather like to really like, and the level of dislike for steamed cake is represented by dislike to slightly dislike. Based on the level of preference, P1 treatment (substitution of okra flour 40 %) had the highest preference level with a total preference percentage of 74.4 %. The characteristic taste of steamed cake in P1 treatment was characterized by unpleasant odour "slightly strong to very strong" 63.2 % and "very weak to weak" 36.8 % (Table 4).

4.3. Texture

The hedonic test results on the texture of the steamed cake are presented in Table 10.

Table 10. Hedonic test results texture of steamed cake

| Treatment | Hedonic Scale (%) | | | | | Total (%) |
|-----------|-------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 0.0 | 19.2 | 31.2 | 49.6 | 0.0 | 100 |
| P2 | 4.8 | 17.6 | 49.6 | 28.0 | 0.0 | 100 |
| P3 | 0.0 | 17.6 | 47.2 | 32.8 | 2.4 | 100 |
| P4 | 0.0 | 16.0 | 37.6 | 44.0 | 2.4 | 100 |
| P5 | 0.0 | 20.0 | 40.8 | 36.0 | 3.2 | 100 |

Table 10 shows that the preference for the steamed cake texture is represented by rather like to really like, and the level of dislike for steamed cake is represented by dislike to slightly dislike. Based on the level of preference, P4 treatment (substitution of okra flour 55%) had the highest preference level with a total preference percentage of 84 %. The characteristic texture of steamed cake in P4 treatment was characterized by tenderness "slightly soft to very soft" 92.0 % and "not very soft to not soft" 8.0 % (Table 5). In addition, P4 treatment was characterized by pore density "slightly dense to very tight" 84.0 % and "very tenuous to tenuous" 16 % (Table 6).

3.4.4. Colour

The hedonic test results for the colour of the steamed cake are presented in Table 11.

Table 11 shows that the preference for the steamed cake colour is represented by rather like to really like, and the level of dislike for steamed cake is represented by dislike to slightly dislike. Based on the level of preference, P3 treatment (substitution of okra flour 50%) had the highest preference level with a total preference of 94.4%. The characteristic colour of steamed cake in P3 treatment was characterized by colour "slightly sharp to very sharp" 84.8% and "very faded to faded " 15.2 % (Table 7).

Table 11 Hedonic test results colour of steamed cake

| Treatment | Hedonic Scale (%) | | | | | Total (%) |
|-----------|-------------------|------|------|------|-----|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| P1 | 0.0 | 19.2 | 36.8 | 44.0 | 0.0 | 100 |
| P2 | 0.0 | 12.8 | 52.8 | 33.6 | 0.8 | 100 |
| P3 | 0.0 | 5.6 | 67.2 | 27.2 | 0.0 | 100 |
| P4 | 0.0 | 12.8 | 44.8 | 40.8 | 1.6 | 100 |
| P5 | 0.0 | 14.4 | 35.2 | 46.4 | 4.0 | 100 |

3.5. Information on Nutritional Value of Steamed Cake

Information on nutritional value can be presented in Table 12

Table 12 The nutritional value of steamed cake with okra flour substitution per serving (100 g)

| Nutrient composition | Nutrition facts | RDA (based on energy requirement of 2000 kcal) |
|----------------------|-----------------|---|
| Energy | 238.35 kcal | 11.91 % |
| Protein | 7.38 g | 14.76 % |
| Fat | 6.37 g | 9.80 % |
| Carbohydrate | 37.87 g | 12.62 % |
| Total fibre | 5.34 g | 17.80 % |

To consume steamed cake, it is recommended to consume 100 grams of steamed cake, which can provide 238.35 kcal of energy, 7.38 grams of protein, 6.37 grams of fat, 37.87 grams of carbohydrates, and a total fibre content of 5.34 grams. The steamed cake with substitution of okra flour aims to meet the energy, protein, fat, carbohydrates and dietary fibre that consumers need. This steamed cake can provide 12% of the daily energy needs for one consumption.

2 Conclusion

The substitution of okra flour in wheat flour affects the total fibre content and volume of the steamed cake development. The higher the substitution of okra flour, the higher the total fibre content, but the lower the development volume of the steamed cake. The average value of total fibre content is 4.16 g - 6.26 g with the volume of expansion is 22.82% to 90.52%.

Based on the results of the hedonic test, most of the steamed cakes were preferred with the level of preference from like to very like. The highest level of preference for taste and odour was P2 treatment (45% substitution of okra flour) with the character of the product having a slightly strong sweet taste, weak bitter after-taste and a rather strong unpleasant odour. The highest level of preference for the steamed cake texture was the P4 treatment (substitution of okra flour 55%) with the character of the soft steamed cake texture and tight pores. The highest level of preference for colour is P3 treatment (substitution of okra flour 50%) with a slightly strong brown colour.

P3 treatment with a substitution of 50% okra flour is the best treatment. The composition of the nutritional value of this steamed cake is 238.35 kcal of energy, 7.38 grams of protein, 6.37 grams of fat, 37.87 grams of carbohydrates, and 5.34 grams of total fibre. The serving size for steamed cake as a food source of dietary fibre is one consumption of one slice (100 grams / consumption)

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