Chemical characteristics of composite flour based on white corn and okara

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Abstract. Composite flour is a flour based from two or more types of flours. In this research white corn and okara were used as composite flour raw materials. This study aimed to determine the ratio of white corn and okara flour effect on chemical characteristics of the composite flour. The research design used in this study was Completely Randomized Design with 1 factor which was the difference ratio of white corn flour and okara flour (100%-0%, 95%-5%, 90%-10%, 85%-15% and 80%-20%). The data obtained was analysed statistically using one-way ANOVA and Duncan’s Multiple Range Test at a significance level of α = 0.05. The results showed the ratio of white corn and okara flour significantly affect the chemical characteristics of the composite flour except moisture content. Higher ratio of okara flour could increase ash, lipid, protein, resistant starch, total dietary fiber, insoluble dietary fiber and soluble dietary fiber content of the composite flour, but decrease carbohydrates, starch, amylose and amylopectin content of the flour. Moisture content of the composite flour were 9.53-9.68%, ash 0.31-0.76%, lipid 1.03-2.62%, protein 7.19-8.73%, carbohydrates 87.89-91.48%, starch 51.00-61.95%, amylose 12.69-13.84%, amylopectin 36.76-48.15%, resistant starch 0.76-1.41%, dietary fiber 10.40-20.15%, insoluble dietary fiber 8.98-17.72%, and soluble dietary fiber 0.83-1.37%.

1. Introduction

Flour is a semi-finished food products that can be used as raw materials in the manufacture of various types of products. There are several kinds of flour that have been used. However, the characteristics of flour sometimes did not meet the expectations. Efforts in the manufacturing of flour with desirable characteristics may be carried out by composite flour manufacture. Composite flour is a flour based from two or more types of flours.

A raw material containing most carbohydrates was needed in the manufacture of flour, because basically the flour was used by its starch content. Otherwise the other content was also needed such as protein, lipid, and minerals. Materials containing functional components such as resistant starch and dietary fiber can also be added to enrich the chemical content of the composite flour that can be helpful for body health. One potential fiber and linoleic acid source that could be explored is okara, besides pea pod and broad bean pod [1]. However, study on composite flour based on okara has not been reported yet.
In this research white corn and okara was used as the composite flour materials. White corn was used as a source of carbohydrates whether okara was used as a source of protein and dietary fiber. White corn has high content of dietary fiber (12-15%) and low glycemic index (28.66-41.37) [2,3]. Okara contains protein 25.4-28.4% and dietary fiber 52.8-58.1% [4]. So this research was conducted by manufacturing composite flour based on white corn and okara flour on various ratio. The aim of this research was investigating the effect of white corn and okara flour ratio on the composite flour chemical characteristics.

2. Research methods

2.1. Materials

The ingredients for producing composite flour were white corn flour obtained from Technopark Grobogan Factory managed by Indonesian Agency for The Assessment and Application of Technology (BPPT) and okara obtained from SMEs of Tofu “Mr.Gundul” in Purwogondo, Kartasura, Sukoharjo, Central Java. All chemicals being used for analysis were pro-analysis grade.

2.2. Tools

Hydraulic press, steamer, pan, gas stove, cabinet dryer, dry mill blender and sieving device were used to produce okara flour, sealed plastic container to mix white corn flour and okara flour, spectrophotometer Thermo Scientific Genesys 20 and glassware to analyse chemical characteristic.

2.3. Research Stages

2.3.1. Okara flour making.

The process of okara flour making was begun by pressing wet okara to separate water. Pressed okara then was steamed for 30 minutes. At the first half time the steamer lid was opened and at the last half time the steamer lid was closed and the temperature was maintained at 90±5°C. The process was continued by pressing the okara and then roasting with continuous stirring for 15 minutes, and drying the okara using cabinet dryer at 60±5°C for 24 hours. The dried okara further was milled using drymill blender and sieved 80 mesh to obtain okara flour [5].

2.3.2. Composite flour making.

Composite flour was made by mixing white corn flour and okara flour with ratio 100%:0% (F1=control), 95%:5% (F2), 90%:10% (F3), 85%:15% (F4), 80%:20% (F5). Mixing was done manually in a sealed plastic container.

2.3.3. Chemical characterization.

Chemical characteristics being analysed were moisture [6], protein [7], lipid [7], ash [7], carbohydrate by difference [7], starch [8], amylose-amylopectin [8], resistant starch [8], and dietary fiber [8].

2.3.4. Data analysis.

The data obtained was analysed using One Way Analysis of Varian. If there was a significant different between samples so further data analysis was conducted using Duncan’s Multiple Range Test at α = 0.05.

3. Results and discussion

3.1. Proximate content

The proximate content of composite flour based white corn and okara can be found in Table 1. It showed significantly differences in ash, lipid, protein and carbohydrate content as the percentage of okara flour was increasing. While the moisture content did not show any significantly difference. Okara flour addition did increase the protein, lipid and ash, yet did decrease the carbohydrate content of the composite flour.
The protein content raised up to 21.42%. Previous research reported that protein content of okara flour was ranging from 25.40%-34.70% [4,9,10] which was higher compared to protein content of white corn flour (10.00%-10.44%)[11,12]. White corn flour used in this research itself contained 6.5% protein.

### Table 1. Proximates content of composite flour based on white corn and okara

| Formula | Moisture content (%wb) | Ash content (%db) | Lipid content (%db) | Protein content (%db) | Carbohydrate content (%db) |
|---------|------------------------|-------------------|---------------------|----------------------|---------------------------|
| F1      | 9.53 ± 0.82a           | 0.31 ± 0.03a      | 1.03 ± 0.10a        | 7.19 ± 0.78b         | 91.48 ± 0.86d             |
| F2      | 9.59 ± 0.76a           | 0.43 ± 0.05b      | 1.79 ± 0.19b        | 7.84 ± 0.36ab        | 89.94 ± 0.51cd            |
| F3      | 9.60 ± 0.73a           | 0.51 ± 0.05c      | 1.84 ± 0.13b        | 8.24 ± 0.66bc        | 89.41 ± 0.65bc            |
| F4      | 9.67 ± 0.63a           | 0.72 ± 0.02d      | 2.23 ± 0.23c        | 8.45 ± 0.65bc        | 88.60 ± 0.80b             |
| F5      | 9.68 ± 0.65a           | 0.76 ± 0.04d      | 2.62 ± 0.29d        | 8.73 ± 0.44c         | 87.89 ± 0.66a             |

* Ratio of white corn flour: okara flour = F1 (100%:0%, control), F2 (95%:5%), F3 (90%:10%), F4 (85%:15%), F5 (80%:20%)

**Different letter in the same column shows a significant difference at α = 0.05.**

### 3.2. Starch content

Starch content of the composite flour will affect the characteristics of the product in the cooking process. During thermal processing starch will allow gelatinization which causes starch granule expand. Starch is a glucose polymer consisting of two components, namely amylose and amylopectin [12]. Amylose content in composite flour affect the difference of peak, setback and final viscosity during pasta formation. While amylopectin affect the characteristics of granule swelling, viscosity, peak temperature, peak viscosity, pasta formation, and gel strength during storage [13]. The ratio between amylose and amylopectin will affect the texture of the product.

Starch, amylose and amylopectin content of the composite flour were shown in **Table 2**. It showed significantly differences in all parameters with decreasing tendency as the okara flour increased. The decrease in these contents was probably influenced by lower levels of starch in the okara flour compared to white corn flour. The composite flour based on white corn and okara contained low amylose which was ranging from 12.69%-13.84%.

### Table 2. Starch content of composite flour based on white corn and okara

| Formula | Starch content (%db) | Amylose content (%db) | Amylopectin content (%db) |
|---------|----------------------|-----------------------|---------------------------|
| F1      | 51.00 ± 1.82a        | 13.84 ± 0.29b         | 36.76 ± 0.58a             |
| F2      | 61.95 ± 2.86d        | 13.80 ± 0.19b         | 48.15 ± 2.97d             |
| F3      | 58.12 ± 0.22c        | 12.69± 0.15a          | 45.07 ± 0.31c             |
| F4      | 56.43 ± 0.60bc       | 12.89 ± 0.34a         | 43.55 ± 0.52bc            |
| F5      | 55.24 ± 0.54bc       | 12.96 ± 0.30a         | 42.28 ± 0.51b             |

* Ratio of white corn flour: okara flour = F1 (100%:0%, control), F2 (95%:5%), F3 (90%:10%), F4 (85%:15%), F5 (80%:20%)

**Different letter in the same column shows a significant difference at α = 0.05.**
3.3. Dietary fiber content

Resistant starch and dietary fiber were functional compounds that have potential benefit to human health. Both resistant starch and dietary fiber cannot be digested by digestive enzymes and resistant to stomach acid. They were important component that have the necessary characteristics in functional food formulation [14]. Dietary fiber consist of soluble dietary fiber and insoluble dietary fiber. Insoluble dietary fiber affected the decrease of glycemic response [15]. Insoluble fiber would form a gel-like texture in the digestive tract that can slow the digestive rate in the intestine and slow the appearance of blood glucose, and provide a longer satiety. Blood sugar levels become more stable because of the need for insulin in transferring glucose into bodycells and converted into less energy [16]. Meanwhile insoluble dietary fiber serves to prevent the occurrence of some diseases, especially those associated with the digestive tract [17].

Table 3 showed significantly difference in the resistant starch and dietary fiber content of composite flour which tends to increase along by the increasing ratio of okara flour. Resistant starch content on the food can be improved by adding nuts and the derived and by products [18].

Table 3. Dietary Fiber Content of Composite Flour Based On White Corn and Okara

| Formula | Resistant Starch Content (%db)** | Total Dietary Fiber Content (%db)** | Insoluble Dietary Fiber Content (%db)** | Soluble Dietary Fiber Content (%db)** |
|---------|-------------------------------|-----------------------------------|---------------------------------------|--------------------------------------|
| F1      | 0.76 ± 0.03a                  | 14.71 ± 2.10a                     | 12.41 ± 1.33b                         | 1.37 ± 0.12d                        |
| F2      | 0.89 ± 0.04b                  | 10.40 ± 0.65a                     | 8.98 ± 1.00a                          | 0.83 ± 0.07a                        |
| F3      | 1.12 ± 0.09c                  | 12.92 ± 0.40b                     | 11.15 ± 0.84b                         | 1.02 ± 0.05b                        |
| F4      | 1.23 ± 0.13c                  | 16.04 ± 0.28d                     | 13.92 ± 0.86c                         | 1.16 ± 0.12c                        |
| F5      | 1.41 ± 0.14d                  | 20.15 ± 0.64e                     | 17.72 ± 1.44d                         | 1.23 ± 0.09c                        |

* Ratio of white corn flour: okara flour = F1 (100%:0%, control), F2 (95%:5%), F3 (90%:10%), F4 (85%:15%), F5 (80%:20%)
** Different letter in the same column shows a significant difference at α = 0.05.

4. Conclusions

White corn and okara flour ratio did not affect the moisture content of the composite flour. Higher ratio of okara flour did result higher ash, lipid, protein, resistant starch, total dietary fiber, insoluble dietary fiber and soluble dietary fiber content of the composite flour. However, higher ratio of okara flour tended to decrease carbohydrates, starch, amylose and amylopectin content of the flour. A further research is needed to find out the physical characteristics and gelatinization profile of the composite flour based on white corn and okara as well as the application of the composite flour in various food products.

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