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Original Article

# Analysis of the nutritional content and acceptability of instant tiwul as a substitute for mocaf flour, green bean flour and jali flour as a high-fiber snack for type 2 diabetes mellitus

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## Abstract

Instant tiwul is a traditional staple food consumed by Javanese people, especially in rural areas and remote mountains. The fiber content in mocaf (cassava) flour is 1.36 g/100g. Green beans have a fiber content of 11.2%. The drying process can extend the shelf life of instant tiwul products. The aim of this research was to determine the effect of the proportion of mocaf flour and green bean flour as well as the effect on sensory characteristic values and nutritional value. Determining the best formulation of instant tiwul products according to consumer assessment. This research used a Completely Randomized Design (CRD) method with 3 treatments. The highest fiber content test results and the best formulation were obtained in instant tiwul from the comparison treatment of 85% mocaf flour and 15% green bean flour. Instant tiwul, made from mocaf flour and green bean flour, has the potential to be a nutritious food that is high in fiber for people with type 2 diabetes mellitus.

**Keywords:** diabetes mellitus, fiber, tiwul.

## Introduction

Diabetes mellitus is a significant degenerative disease throughout the world, with numbers continuing to increase. The International Diabetes Federation (IDF) organization estimates that 463 million people (9.3%) in the world suffer from diabetes mellitus and it is predicted that this will continue to increase, reaching 578 million in 2030 and 700 million in 2045 [1]. According to IDF projections, Indonesia is ranked 7th of the 10 countries with the highest prevalence of diabetes mellitus, 10.7 million people and is the only country in Southeast Asia to be on the list [2]. Diabetes Mellitus has an impact on long-term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels [2, 3]. Management of diabetes mellitus is carried out by implementing five pillars, namely providing education, medical, nutritional therapy, physical activity, pharmacological therapy and blood glucose checks. Medical nutritional therapy is an important part of managing diabetes mellitus, one of which is done by adjusting diet, such as consuming complex carbohydrate sources with a low glycemic index and consuming foods high in fiber [4]. Adequate fiber intake can increase insulin action in regulating blood glucose, slowing gastric emptying and providing a longer feeling of fullness [5]. Research shows a significant relationship between fiber intake and blood glucose levels, where the higher the fiber intake, the lower the blood glucose levels [6].

One type of cereal food that contains high fiber with a relatively low glycemic index (GI) is cassava. Cassava has a high fiber content, especially when made into flour, amounting to 7.2 grams per 100 grams [7]. The glycemic index of mocaf flour is relatively low, namely 42 [8]. Foods with a low glycemic index can improve blood glucose response, and consuming foods that have a low glycemic index value helps reduce blood glucose levels slowly, which will help control blood glucose levels in the body [9]. Several studies have shown the effect of giving corn on blood glucose; there was a significant difference in blood sugar levels in Wistar rats fed a diet of corn flour substituted with tempeh flour and rats fed a standard diet [10].

Apart from cassava, other types of nuts, one of which is green beans, are also a source of cereals that contain fiber [11]. Green beans have a relatively high fiber content compared to other beans [12]. The fiber content in green beans is around 7.5 g/100 g, higher than that of red beans, which contain fiber 4 g/100 g, and peanuts 2.2 g/100 g [13]. Besides being high in fiber, green beans also have a low glycemic index value of 50 [9]. The research results on Wistar Bunting Rats (Rattus novergicus) proved that giving green beans prevented increases and controlled blood glucose levels [11]. Tiwul is a dry processed food product in granular form and is generally a practical snack suitable for people with type 2 diabetes mellitus so they do not miss their meal schedule.

## Material and methods

This research used a quantitative experimental method with a Completely Randomized Design (CRD) research design, including the formulation process for making instant tiwul, organoleptic quality analysis, and nutritional content quality analysis. This research was carried out at the Food Technology Laboratory of the Ministry of Health's Semarang Health Polytechnic in May–June 2024. This research has ethical approval from the Semarang Ministry of Health Polytechnic Research Ethics Committee with No. 012106040.

The subjects involved in the research were panelists who were not trained according to the criteria of being physically and mentally healthy, not fasting, not hungry, and not allergic to the composition of the ingredients used in making instant tiwul.

The equipment used in this research includes tools for making instant tiwul, including analytical scales, baking pans, basins, steamers, saucers, small bowls, blenders, grinders, and cabinet dryers.

The raw materials used in this research include ingredients for making instant tiwul, namely mocaf flour, green bean flour and jali flour.

### Formulation for making tiwul

In making instant tiwul, 3 formulations are used with the experimental factors of the proportion of mocaf flour, green bean flour and jali flour with the formulation as in Table 1.

Table 1: Instant tiwul formulation.

| Ingredients (gr) | F1 | F2 | F3 |
|---|---|---|---|
| **Mocaf flour (gr)** | 85 | 75 | 65 |
| **Green bean flour (gr)** | 15 | 25 | 35 |
| **Jali flour (gr)** | 10 | 10 | 10 |

Making instant tiwul was carried out using the method from Widiatmoko (2015) with modifications. The ingredients needed to make instant tiwul are prepared and weighed on the mocaf flour, green bean flour and jali flour according to the treatment, then formed into a ball while adding 4 ml of water. Then steamed for 15 minutes and dried again for 4 and 6 hours at a temperature of 50˚C.

### Organoleptic test analysis procedure

Organoleptic quality testing uses hedonic tests involving 30 untrained panelists to assess the products produced. Parameters assessed by panelists include color, aroma, texture, taste and overall preference. The hedonic scale used is (1) do not like it, (2) do not like it a little, (3) like it a little, (4) like it, and (5) like it a lot [13].

### Analysis procedure of nutrient content

Nutrient content analysis carried out on instant tiwul includes carbohydrate analysis using the Nelson-Somogyi method, protein analysis using the micro kjedahl method, fat analysis using the soxhlation method, water analysis using the oven method, ash analysis using the wet ashing method, and fiber analysis using the gravimetric method.

### Data analysis techniques

The research data were analyzed using the SPSS version 22 for Windows software program. Analysis of

organoleptic quality data (color, texture, taste, aroma, overall) and analysis of nutritional content quality data (carbohydrates, protein, fat, water, ash and crude fiber) used the One Way ANOVA method at a confidence level of α=0.05. Further statistical tests using DMRT (Duncan Multiple Range Test) for significantly different treatments.

## Results

### Organoleptic test

The results of the organoleptic test analysis in this study using parameters assessed including panelists' preferences in testing instant tiwul samples are shown in Table 2. The results in Table 2 show that the panelists' preference scores for instant tiwul ranged between 3.3 and 3.95 on the color parameter. The results of One Way ANOVA statistical analysis at the 95% confidence level show that instant tiwul does not have a significant difference (p=0.433). Panelists' favorite values for parameters ranged between 3.2–3.5 and showed no significant difference (p=0.075).

The panelists' preference scores for taste parameters ranged from 2.7 to 4.70 and did not have a significant difference (p=0.141). The panelists' preference values for aroma parameters ranged from 3.33 to 4.05 and did not have a significant difference (p=0.967).

The panelists' preference scores for overall preference parameters ranged from 3.13 to 2.97 and showed that there was no significant difference (p=0.625).

The selected product is selected based on the largest value for the overall attribute and considering the highest value and level of substitution in the same column in the test results Duncan continued.

### Nutrient content test

The results of the research show that carbohydrate (total sugar) levels range between 73.74–79.09%, as presented in Table 3. The results of One Way ANOVA statistical analysis at the 95% confidence level show that instant tiwul has a significant difference in carbohydrate (total sugar) levels (p=0.001) Further DMRT analysis showed that the carbohydrate levels at each treatment level were significantly different.

Table 3 shows that protein levels have a significant effect (p<0.001). Further DMRT analysis showed that the protein levels of instant tiwul at each treatment level were significantly different. The research results showed that the fat content of instant tiwul made from mocaf flour and green bean flour ranged from 5.36–8.31%. Table 3 shows that fat content has a significant influence (p<0.001). Further DMRT analysis showed that the fat content at each treatment level was significantly different.

The research results showed that the water content ranged between 12.39–15.63% as presented in Table 3. The research results showed that instant tiwul did not have a significant difference (p=0.954).

The ash content of instant tiwul ranged from 1.82–2.08% as presented in Table 3. The results of statistical analysis showed that all formulations had a significant effect (p<0.001). The crude fiber content of instant tiwul ranges from 13.56–45.92%. Table 3 shows that there is a significant difference (p=0.013).

Table 2: Hedonic test results.

| Parameter | F1 | F2 | F3 | p |
|---|---|---|---|---|
| **Color** | 3.95 | 3.65 | 3.3 | 0.433 |
| **Aroma** | 4.05 | 3.6 | 3.3 | 0.967 |
| **Taste** | 3.7 | 2.7 | 2.75 | 0.141 |
| **Texture** | 3.5 | 3.2 | 3.2 | 0.075 |
| **Overall** | 3.8 | 3.2875 | 3.1375 | 0.625 |

## Discussion

### Organoleptic properties of instant tiwul

Color parameters are important sensory characteristics in the presentation of food to determine the level of consumer acceptance of a product [14]. The instant tiwul color produced in this study showed that the panelists' assessments ranged from slightly disliking to slightly liking. Based on color parameters, F1 instant tiwul was acceptable to panelists with a score of 3.95 (likes). F3 instant tiwul with a value of 3.37 (somewhat like it) shows that the panelists do not like the instant tiwul. The panelists' preference for instant tiwul decreased as the concentration of green bean flour increased. The addition of high levels of green bean flour shows that the color tends to fade [15].

The color of instant tiwul is influenced by the color of the raw materials used in processing tiwul. Generally, the tiwul that panelists prefer is brown [15]. However, the color produced by instant tiwul is not much different from mocaf flour, namely brown [16]. Texture has a role in determining a food product by looking at


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Table 3: Results of instant tiwul nutrient content analysis.

| Formula | Energy | Protein | Fat | Carbohydrate | Fiber | Ash Rate | Water rate |
|---|---|---|---|---|---|---|---|
| **F1** | 359.86 | 5.36 | 1.34 | 79.09 | 45.92 | 1.82 | 12.39 |
| **F2** | 343.23 | 7.74 | 0.91 | 76.02 | 34.93 | 2.08 | 13.25 |
| **F3** | 331.8 | 8.31 | 0.4 | 73.74 | 13.565 | 1.92 | 15.63 |
| **p** | | 0.001 | 0.001 | 0.001 | 0.013 | 0.001 | 0.954 |

its size, shape, and quantity and can be felt by the senses of taste and touch (elements in the formation of ingredients) [17]. The results of the research show that the preference value for the texture of instant tiwul ranges from slightly dislike to slightly like. Based on texture parameters, F1 instant tiwul was acceptable to panelists with a score of 3.5 (rather like it). F3 instant tiwul with a value of 3.2 (rather like it) indicates that the panelists did not like the instant tiwul.

The taste of a product is the result of the interaction of several senses, namely the senses of sight, smell, hearing and touch [18]. The results of the research show that the panelists' ratings of instant tiwul ranged from slightly disliking it to slightly liking it. Based on taste parameters, F1 instant tiwul was acceptable to panelists with a score of 3.7 (like). F3 instant tiwul with a value of 3.33 (rather like it) shows that the panelists do not like the instant tiwul. The level of panelists' acceptance of the taste of instant tiwul varies, this is because mocaf bean flour and green flour provide a distinctive taste on the tongue [18]. Aroma is one of the quality characteristics whose value is contained in the product, which can be directly enjoyed by consumers [19]. The research results showed that the level of liking for the aroma of instant tiwul ranged from slightly disliking it to slightly liking it.

Based on aroma parameters, F1 instant tiwul was acceptable to panelists with a score of 4.05 (like it very much). F3 instant tiwul with a value of 3.33 (somewhat like it) shows that the panelists do not like the instant tiwul. The level of panelists' acceptance of the aroma of instant tiwul tends to vary. This is because the aroma of instant tiwul tends to be the same at several levels of treatment with the addition of mocaf flour and green bean flour so that the panelists did not show significant differences [20].

Overall liking is one aspect in the panelists' liking test for all organoleptic aspects of instant tiwul [15]. Organoleptic aspects include color, texture, taste and aroma of a product. The panelists' level of assessment of the overall instant tiwul produced ranged from slightly like it to like it. The highest overall score for panelists' instant tiwul was instant tiwul F1, 3.8 (liked), while instant tiwul F3, with the lowest score, was 3.13 (somewhat liked). The low acceptability of instant tiwul is caused by the less attractive color and distinctive taste.

## Instant tiwul nutritional value

### Carbohydrate (total sugar)

The research results in Table 3 show that the carbohydrate content (total sugar) of instant tiwul made from mocaf flour and green bean flour was the highest in the F1 treatment, namely 79.09% with a ratio of mocaf flour and green bean flour (85:15). SNI does not require instant tiwul carbohydrate content values to be at certain limits. The lower the concentration of mocaf flour, the lower the carbohydrate content. This is caused by the carbohydrate content in mocaf flour being higher than the carbohydrate content in wheat flour, namely 84.17% [20], while wheat flour is 72.28% [21]. Instant tiwul, as a result of this research, is lower than instant tiwul without substitutions as a result of research by Soleh (2011), whose carbohydrate content was 77.82% [15]. The value of carbohydrate content in the product is influenced by the type of flour used, namely mocaf flour and green bean flour.

### Protein

The high concentration of green bean flour in this study resulted in higher protein levels in instant tiwul. This is because green bean flour has a high protein content, namely 12–15% [22]. The research results in Table 3 show the highest protein content in the F3 formulation treatment, namely 8.31%. Based on SNI 3551:2012, the protein content of instant tiwul is at least 8% [23].

Consuming foods with high protein can delay or reduce hunger so that diabetes mellitus sufferers can avoid excessive eating habits that result in obesity [24].

### Fat

The research results in Table 3 show that the highest tiwul fat content in this study was in the F1 treatment,

namely 1.34%. SNI does not require the fat content of instant tiwul to be at a certain limit. The higher the concentration of mocaf flour, the higher the fat content; this is influenced by the fat content of mocaf flour, which is 14.8% [25]. The ingredients used in making tiwul affect the fat content of tiwul products [25].

### Water rate

In this study, the water content of instant tiwul made from mocaf flour and green bean flour was the highest, namely in the F3 treatment, namely 15.63%. Based on SNI 3551:2012, the water content of instant tiwul is a maximum of 10% [23]. The water content of instant tiwul as a result of research still does not meet standards, but is still quite suitable for consumption because it does not have many different values [26].

### Ash rate

The instant tiwul ash content in Table 3 shows the highest results, namely in the F2 treatment, namely 2.08%. The lowest ash content value was in the F1 treatment. The ash content value of instant tiwul is higher along with the higher concentration of green bean flour. This is because the mocaf flour and green bean flour used have an ash content of 2.98% [20] and 8.87% [25], which is greater than wheat flour, namely 0.54% [21]. According to SNI 3551:2012 concerning quality requirements for instant tiwul, it states that the maximum ash content of instant tiwul is 3% [23]. The instant tiwul ash content of all formulations still meets the characteristics or quality requirements of dry food based on SNI 3551:2012, namely 2.63% and 2.95%.

### Fiber

The instant tiwul fiber content in Table 3 shows the highest value, namely in the F1 treatment, namely 45.92%. SNI does not require instant tiwul fiber content to be at a certain limit.

The higher the fiber content in food, the better it is for digestion. Relatively high fiber foods can help reduce the occurrence of several diseases such as diabetes, heart disease and obesity [25].

## Conclusion

Mocaf and green bean instant tiwul, which has the best formulation based on the results of organolectic tests, nutritional value, is the F1 formulation (85% mocaf flour: 15% green bean flour). Tiwul instant formulation P1 has a high fiber content of 45.92% and can reduce blood glucose response so it has the potential to be a healthy food suitable for consumption by diabetes mellitus sufferers. The weakness of this research is that there needs to be more variety of flavors which is expected to increase fiber consumption through instant tiwul. Suggestions for further research include extending the reformulation by using a variety of other ingredients so that they can provide better organoleptic properties and increase fiber content.

## Conflict of interest

The authors declare no conflict of interest.

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