Characteristics of Analogue Rice Based on Taro (Colocasia sp.) from Mentawai Islands Regency with a Mixture of Mocaf and Soybean Flour (Glycine max l.)

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ABSTRACT

Research on the manufacture of taro-based analog rice with a mixture of soy flour and mocaf as a food diversification to reduce the large rice consumption in Indonesia has been carried out. This study aimed to obtain the most appropriate formulation of taro, soybean flour, and mocaf for making analog rice. This study used a completely randomized design (CRD) method where the treatments used were different formulations of soybean flour at 4 levels (10%, 20%, 30%, and 40%) and mocaf flour at 4 levels (40%, 30%, 20%, and 10%). The results showed that the closest analog rice formulation regarding chemical and physical characteristics based on the SNI Standard for rice was found in formulation C, namely 50% taro, 30% soybean flour, and 20% mocaf. The chemical characteristics of the analog rice are starch content of 37.72%, amylose of 14.88%, amylopectin of 22.84%, protein of 14.09%, fat of 10.64%, dietary fiber of 22.70%, energy value of 407.63 kcal, 2.92% ash, 63.87% carbohydrates, and 8.48% moisture content. The best physical characteristics of analog rice are hardness (130.36 N/cm²), medium length and shape, and one thousand-grain weight (15.93 g).

1. INTRODUCTION

1.1 Research Background

Indonesia is the country with the highest level of rice consumption in Asia. Based on data from the BPS National Susenas, the average Indonesian person consumed 103.18 kg/capita/year of rice from 2002–2013 [1]. This figure is higher when compared to other countries such as Korea (40 kg/capita/year), Japan (50 kg/capita/year), Thailand (70 kg/capita/year), and Malaysia (80 kg/capita/year) [2]. As the staple food of most people, the need for rice will increase yearly in line with population growth.

Food diversification is one effort that can be implemented to reduce the large consumption of rice in Indonesia. Indonesia has many other sources of carbohydrates, such as corn, cassava, sorghum, and other tubers. These food ingredients can be used as energy sources besides rice [3]. One alternative that needs to be developed as a source of carbohydrates is the development of root crops. Taro is a source of carbohydrates other than rice and starch that can be used for food processing. One area in Indonesia with a high taro plant population is the Mentawai Islands Regency.

The most significant carbohydrate component of taro is starch (77.9%), which consists of 17–28% amylose and 72–83% amylopectin [4]. Taro also has easy-to-digest properties. The fiber content in taro is also high, reaching 5.3 grams, or 20.5%, to meet daily fiber needs [5].

Analog rice is one of the strategies for food diversification because it is expected to be close to the original form of rice so that the people who consume it feel that they are consuming rice [6]. Analog rice imitates rice made from ingredients such as tubers and cereals that look like rice [7].

Tubers, including taro, generally have a relatively low protein content. Soybeans belong to the legume family and can be used as a source of vegetable protein [8]. Then, to improve the texture of analog rice, it is necessary to add mocaf flour. Mocaf flour is a product derived from cassava flour that uses the principle of modifying cassava cells by fermentation by lactic acid bacteria. Mocaf is expected to be used as a food additive to improve the texture of analog rice because mocaf has starch with low viscosity, so it doesn't stick when added to water [9].
1.2. Research Objective

This study aims to obtain the best formulation of taro-based analog rice from the Mentawai Islands Regency with a mixture of mocaf and soybean flour to analyze the effect of adding mocaf and soybean flour at various formulation levels on the physical and chemical characteristics of the analog rice produced.

2. MATERIALS AND METHODS

2.1. Material

The primary raw material used in this study was taro obtained from the Tuapejat area, North Sipora, Mentawai Islands Regency, and West Sumatra. Soybean flour, which is used to increase protein content, and mocaf flour are obtained from the market in Padang.

2.2. Method of Making Analog Rice

The raw taro materials are sorted, peeled, cut into four parts, then steamed for 30 minutes. The steamed taro is mixed with soybean flour and mocaf (according to the formulation), then mashed using a mixer for 10 minutes. The dough is put into a double screw extruder at a speed of 5 kg of material per hour, and the temperature of the incoming material is warm (70–80 °C) until wet analog rice is obtained. Furthermore, analog rice is dried in an oven at 60 °C for 2 hours.

2.3. Observational Variables

For analog rice, chemical analysis was carried out, including starch content, amylose content, amylpectin content, protein content, fat content, dietary fiber, energy value, ash content, carbohydrate content, and water content. Physical observations included the analog rice hardness test, the size and shape of the analog rice, and the weight of one thousand grains.

2.4. Experimental design

This study used an experimental design with a completely randomized design (CRD). The treatment used in this study was the difference in the formulation of the addition of soybean flour, which consisted of 4 levels (10%, 20%, 30%, and 40%), and the addition of mocaf flour, which consisted of 4 levels (40%, 30%, 20%, and 10%).

3. RESULT AND DISCUSSION

3.1. Chemical Characteristics of Analog Rice

3.1.1. Starch Content

The starch content of the analog rice produced in this study was 35.97% to 56.39%. The higher the concentration of mocaf given, the higher the starch analog of rice produced. Compared with analog rice made from yellow sweet potato, which has been studied, where the starch content was obtained at 44.5%, this value is still the same as the starch content of the taro analog rice produced [10].

Starch is a food reserve composed of polysaccharides from a D-glucose molecule found in all plant cells. The starch molecule is divided into two fractions, namely amylose, referred to as the soluble fraction, and amylpectin, referred to as the insoluble fraction. Amylose is a straight chain composed of 1,4-D-glucose bonds and amylpectin is composed of 1,4-D-glucose bonds and has a branched structure [11].

3.1.2. Amylose content

The amylose content of the analog rice produced showed a decrease from treatment A to treatment D. This decrease in amylose content coincided with the decrease in the mixing of mocaf and the increase in the addition of soybean flour. The highest amylose content produced was found in treatment A, 27.48%, while the lowest was found in treatment D, around 12.37%.

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Rice is grouped into four parts based on its amylose content: rice with a high amylose content of 25–33%, rice with a moderate amylose content of 20–25%, rice with a low amylose content of 9–20%, and rice with a very low amylose content of 9% [12]. Suppose the amylose content of analog rice made from taro with a mixture of mocaf and soybean flour from various treatments are grouped. In that case, it is included in the low, medium, and high amylose content groups. The amylose content influenced the high amylose content of the analog rice obtained in the raw material, namely the taro, and the concentration of adding mocaf.

Amylose is a part of starch, which is soluble in water and has a straight chain. The amylose content is around 17–20% and consists of glucose units consisting of 1-4 D-glucose bonds. The nature of amylose is co-possibility, so it can be used as a source of raw material for making extruder food products [13].

3.1.3. Amylopectin content

The amylpectin content of the analog rice produced showed a decrease from treatment A to treatment D. This comparison between amylose and amylpectin from analog rice could determine whether the rice texture is flavored or not, how quickly it hardens, whether the rice is sticky or not, and the color and gloss [14]. In this study, the highest amylpectin content produced was in treatment A, 28.90%, while the lowest was found in treatment C, around 22.84%.

Amylopectin is part of starch, which is insoluble in water and has a branched chain structure. Amylopectin consists of glucose units that have 1-4 D-glucose and 1-6 D-glucose bonds. Amylopectin stimulates the process of puffing and is light, crisp, and crunchy in food products [15].

3.1.4. Protein

The resulting analog rice protein content increased from treatment A to treatment D. This increase in protein content coincided with the increasing amount of soy flour mixed and the small addition of mocaf during the processing. The higher the addition of soybean flour, the higher the protein content of the rice analog produced. The highest protein content produced was found in treatment D, 15.26%, while the lowest protein content was found in treatment A, around 5.70% when compared with analog rice made from yellow sweet potato that has been studied and white rice and IR 64 rice on the market, where the protein content of each is 3.33%, 7.5%, and 7.39, the protein content value of analog rice made from taro with a mixture of mocaf with higher soy flour.

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The fat content of the analog rice produced showed an increase from treatment A to treatment D. This increase in fat content coincided with an increase in soy flour mixing and a decrease in mocaf. This is caused by the fact that soybean flour has a high-fat content compared to mocaf.

The highest fat content produced in this study was found in treatment D, 13.66%, while the lowest protein content was found in treatment A, around 3.51%. When compared with analog rice made from yellow sweet potato that has been studied and white rice and IR 64 rice on the market, where the fat content is respectively 0.64%, 1.9%, and 0.19, the value of the fat content of analog rice is made from taro with a mixture of mocaf with higher soy flour. Fat is a food substance that is very important for the human body and affects health. In addition, fat also acts as a very effective energy source compared to protein and carbohydrates [18].

From a nutritional standpoint, fat is an organic compound that provides energy of as much as 9 kcal/g and is a more significant contributor when compared to carbohydrates and proteins, each producing energy of 4 kcal/g. The nature of fat plays an essential role in the characteristics of the food produced because it affects taste and oiliness [19].

3.1.6. Dietary fiber

The food-fiber analog rice produced increased from treatment A to treatment D. The increase in dietary fiber content coincided with the increase in soy flour mixing and the decrease in mocaf. This is because soybean flour has a high fiber content compared to mocaf.

The highest food fiber content produced in this study was found in treatment D, 28.30%, while the lowest was found in treatment A, around 13.20%. The dietary fiber content of the rice produced in this study was higher than that of the yellow sweet potato analog at 11.75%. The content of dietary fiber is also more significant when compared to the content of dietary fiber in white rice, which is equal to 6.80% [20]. These results indicate that analog rice can be an alternative for those on a diet program.

Dietary fiber, also known as dietary fiber, is part of complex carbohydrates that are difficult to absorb by the digestive tract and difficult to decompose by enzymes. The function of dietary fiber...
is to maintain a healthy body as an important component in the diet and can prevent disease [21].

3.1.7. Energy value

The energy value of the analog rice produced showed an increase from treatment A to treatment D. The highest energy value produced in this study was in treatment D, which was 414.85 kcal, while the lowest energy value was found in treatment A, which was around 377.03 kcal. The energy value of analog rice in this study was higher when compared to yellow sweet potato analog rice, at 366.72 kcal. The energy value is also more significant when compared to the energy value of white rice, which is 357 kcal. This is proportional to the total value of the analog rice's fat, protein, and carbohydrate content. The higher the fat, protein, and carbohydrate levels, the higher the energy value of the analog rice produced, and vice versa.

3.1.8. Ash content

The resulting analog rice ash content increased from treatment A to treatment D. The highest ash content produced in this study was in treatment D, which was 3.76%, while the lowest ash content was in treatment A, around 1.84%. Ash content is a mineral element in food that is not completely burned during combustion [22]. The high ash content of a food is directly proportional to the number of mineral elements present. The ash content of taro-based analog rice mixed with mocal and soybean flour was higher than that of yellow sweet potato, 1.31%, and the ash content of white rice, 0.8% [23].

In the processing of food ingredients, such as the manufacture of analog rice, the analysis of ash content is very important to do, which can determine whether analog rice is good or not and has a relationship to the mineral content of the food product [24].

3.1.9. Carbohydrate content

The carbohydrate content of analog rice produced showed a decrease from treatment A to treatment D. The highest carbohydrate content produced in this study was in treatment A, which was 80.67%, while the lowest carbohydrate content was found in treatment D, which was around 57.71%. The carbohydrate content of analog rice decreased with increasing proportions of soybean flour. The carbohydrate content of this analog rice is in the range of 57.71–80.67%, lower than the yellow sweet potato analog rice that has been studied, which is 85.18%, and almost the same as white rice, which has a carbohydrate content of 77.1%, and IR64 rice of 79.64% [25]. The lower carbohydrate content is due to the substitution of soybean flour, which increases the protein content so that the carbohydrate content is lower.

Carbohydrates are a source of energy the human needs to support daily activities, which means that the more carbohydrates consumed, the more energy the body produces. In addition, carbohydrates also function as structure-forming materials and form hydrocolloids [26].

3.1.10. Water content

The water content of the analog rice produced increased from treatment A to treatment D. The highest moisture content produced in this study was in treatment D, which was 9.60%, while the lowest water content was found in treatment A, around 8.29%. From the results of this study, the water content of analog rice has met the quality requirements of SNI rice (SNI 6128: 2008), where the maximum water content is 14%. The value of the water content of analog rice is also strongly influenced by the raw material of the analog rice itself, the amount of water added to the product, and the length of the drying process that is carried out. Moisture content is vital in food’s appearance, texture, and taste. High water content can increase the growth of bacteria, mold, and yeast, resulting in changes in food ingredients [27].

3.1.11. Analog Rice Hardness

The resulting analog rice hardness showed a tendency to increase from treatment A to treatment D. The highest hardness value produced in this study was in treatment C, which was 130.36 N/cm², while the lowest hardness value was in treatment A, which was around 63.36 N/cm². The higher the starch content in analog rice, the higher the amylase content, and the harder the texture of the rice.

The hardness of a food ingredient is strongly influenced by the water content, where the higher the water content of the food, the lower the hardness level, or conversely, the lower the water content of the material, the higher the hardness level. The low value of the water content in analog rice makes the hardness level higher. The food's amylase content is another factor affecting the hardness level [28]. Hardness is the durability property of food due to the application of pressure. The hardness value is obtained by applying the highest compressive force to the food sample until the material is broken or crushed [29].

3.1.12. Size and Shape of Analog Rice

From the results of observations, analog rice has a length of 6.68 mm to 6.91 mm. Based on these data, the resulting analog rice is grouped into medium-shaped rice [30]. At the same time, the results of observations on the shape were calculated based on the ratio of the length/width of analog rice, which has a shape size of around 2.43 mm to 2.67 mm. Based on these data, the resulting analog rice is grouped into long-sized rice [31].

The size and shape of analog rice were determined from the rice grains of each treatment, which were measured using calipers and determined on a millimeter (mm) scale. Meanwhile, to determine the shape of the analog rice produced, the ratio of length to width is determined, which is then determined in oval, medium, slightly round, and round shapes [32].

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Table 2. Physical Characteristics of Taro-Based Analog Rice with a Mixture of Mocaf and Soybean Flour with Various Formulations

<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness Value (N/cm²)</td>
<td>63.36±20.47²</td>
<td>116.73±20.48²</td>
<td>130.37±57.46²</td>
<td>119.22±43.12²</td>
</tr>
<tr>
<td>Size (mm)</td>
<td>6.91±0.12²</td>
<td>6.68±0.19²</td>
<td>6.80±0.10²</td>
<td>6.79±0.18²</td>
</tr>
<tr>
<td>Analog rice shapes (mm)</td>
<td>(Long)</td>
<td>(Long)</td>
<td>(Long)</td>
<td>(Long)</td>
</tr>
<tr>
<td>Thousand-grain weight (g)</td>
<td>15.78±0.13²</td>
<td>15.86±0.15²</td>
<td>15.93±0.13²</td>
<td>18.16±0.35²</td>
</tr>
</tbody>
</table>

Information:
A = 50% taro; 10% soybean flour; 40% mocaf; B = 50% taro; 20% soybean flour; 30% mocaf; C = 50% taro; 30% soybean flour; 20% mocaf; D = taro 50%; soybean flour 40%; mocaf 10%. a, b, c, d = If the letter notation is different, then there is a significant difference in Duncan's test at the 5% level.

4. CONCLUSION

The most appropriate analog rice formulation is made from taro from the Mentawai Islands Regency with a mixture of soybean flour and mocaf based on the SNI Rice Standard, compared with yellow sweet potato analog rice that has been studied and white rice IR 64, obtained in formulation C which is 50% taro, 30% soybean flour, and 20% mocaf. The chemical characteristics of the best analog rice were starch content 37.72%, amylose content 14.88%, amyllopectin content 22.84%, protein content 14.09%, fat content 10.64%, dietary fiber 22.70%, energy value 407.63 kcal, ash content 2.92%, carbohydrate content 63.87%, water content 8.48%. The best physical characteristics of analog rice were the hardness test of 130.36 N/cm², medium length and shape, and a one-thousand-grain weight of 15.93 g.

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