The effect of cassava and corn flour utilization on the physicochemical characteristics of cassava leaves snack

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Abstract. Cassava leaves are nutritious vegetable, but often regarded as an inferior commodity. One of the efforts increasing in the benefit of cassava leaves is through processing it into snack. In order to support the food diversification program and to reduce the dependence on imported commodities, the development of cassava leaves snack could be accompanied by optimizing the use of local materials to minimize the use of wheat flour. The aim of this assessment was to learn the effects of cassava and corn flour substitution on the physicochemical characteristics of cassava-leaves snack. The substitution of local flour (cassava and corn) on the snack production was carried on three levels at 15, 30, and 45%. A control treatment was using 100% wheat flour. The results showed that cassava and corn flour were potential to substitute wheat flour for making cassava-leaves snack. The substitution of cassava and corn flour as much as 45% was able to produce crispy products with a brighter color. The substitution of corn flour was resulting in snacks with the lower content of lipid than the other substitution snacks.

Keywords: cassava leaves, substitution, local flour.

1. Introduction

Cassava leaves, like other vegetables, are rich in vitamin and mineral. Cassava leaves are containing highly nutrient, such as vitamin A (1970 µg RE), vitamin C (311 mg/100 g), protein and carbohydrates [1]. During this time, cassava leaves were often regarded as inferior vegetables, which have low market price. In relation with this condition, various processing technologies have been developed not only to increase the added value of cassava leaves but also the consumption level of vegetables. One of technology that simple and suitable to be developed in village is processing the cassava leaves into snack.

Snack is one of processed food products that very popular in Indonesia. Nowadays, consuming snack has become a part of lifestyle and its production is increasing more from year to year. Based on that condition, product development such as cassava-leaves snack is one of the attempts in supporting the food diversification program and increasing vegetable consumption that aimed to improve the nutritional status of Indonesian community.

In Central Java, the production of snack from cassava leaves has been developed in such way to produce a unique flavor that favorable by customers. In its production, the producers still rely on
wheat flour as the main ingredient. Dependency of local products on wheat flour as a raw material is quite apprehensive considering that wheat is an imported commodity. To overcome this condition, the use of flour from local commodities as an alternative of wheat substitution should be developed.

Corn and cassava are local food crops with a great potency to be developed as an alternative material in wheat substitution. Both of these crops are common cultivated by Indonesian farmer because its cultivation is relatively simple. Although study on the utilization of corn flour and cassava flour has been widely developed especially for bread and noodles, but its utilization for snack products was still not considered. Each type of flours has different property, so that study would evaluate the effects of corn and cassava flour utilization on the physicochemical characteristics of cassava-leaves snack.

2. Material and method
The production of cassava leaves snack refers to a method developed by women-farmers in Seboto village, district of Boyolali, Central Java. The ingredients for preparing snack are cassava-leaves (mix between green and dark leaves with ratio 1:3), wheat flour, tapioca, eggs, butter, and some condiments. The cassava and yellow corn flour substituting wheat flour in the production of snack were obtained from Boyolali farmer. The substitution level variations of flour (cassava and corn) in the production of snack were 15, 30, and 45% of the wheat flour weight. Snack made of 100% wheat flour were used as a control treatment. The instruments used in this study were grinder, electric single fryer (Fomac FRY.E2LI), slicer, digital scales, and other supporting tools.

The processes of snack production firstly began to boil the cassava leaves for 30 minutes. Afterward the boiled leaves were squeezed to reduce the water content. The leaves then finely ground and mixed with flour and other ingredients to form sturdy dough. Next, the dough was flattened into a thin sheet before it was deep-fried in the hot oil (190 ± 5°C). The snacks were fried twice to obtain a crunchy texture. The first frying was carried out for 5 minutes, while the second was done for 1 minute. At the end of frying, snack were drained to reduce the excess oil. The snacks were allowed to cool at room temperature, then packed in 0.08 mm polyethylene (PE) bag and stored in airtight container before further analysis. All treatments were replicated three times.

Analysis of snack quality attributes comprised its physical and chemical properties. The physical analysis included the hardness level (Instron Universal Testing Machine Instron Corporation, Canton, MA) and the color of product (Hunter Lab Scan Spectrocolorimeter). Chemical analysis consisted of moisture content [2], protein [3], and total lipid [2].

Experimental data were statistically analyzed using one-way analysis of variance (One Way ANOVA). Detailed examinations for significant differences were done using a Duncan Multiple Range Test at p ≤ 0.05. SPSS 17.0 statistical software (SPSS Inc., Chicago, IL, USA) was used in all statistical analysis.

3. Result and Discussion

3.1. Physical characteristics of cassava leaves snack
Hardness level is one of the important quality parameters on the snacks because it related to the crispness, which is one of the main consumer considerations in buying snacks. Crispness may associate with some characteristics of products such as firmness, brittle, and a specific sound when it is broken [4]. In snacks, a decrease of crispness can become the main reason of product rejection [5].

The effect of local flour (cassava and corn) substitution on the hardness level of cassava-leaves snack was presented in Figure 1. The results showed that the more amount of cassava or corn flour as the substitution material then the hardness level of snack were tend to decreased, in other words the products became crunchier. The degree of hardness was also determined by the protein content of the constituent materials [6].

Protein is long peptide chains, which requires a high energy to break it. Wheat flour has higher protein content than cassava and corn flour. Wheat flour used in this study was included in the
moderate protein content group ranging from 12 to 13%. In the other hand, the protein content of cassava and corn flour in this study were 2.0 and 4.0% respectively (data not shown). The lower protein content on this substitution material was alleged to be the cause of the hardness decline.

![Figure 1](image)

Figure 1. The effect of cassava and corn flour substitution on the hardness level of the snacks

Besides crispness, the color of product is also one of main factors that affected costumer acceptance. Color would visually appear first and often determine a product value [7]. Table 1 shows the effect of cassava and corn flour substitution on the color of cassava-leaves snack. The use of cassava and corn flour as the substitution material of wheat flour on the production of cassava-leaves snack has significant effect on the lightness (L*), index of redness/greenness (a*), and index of yellowness/blueness (b*).

| Treatments          | L*             | a*             | b*             |
|---------------------|----------------|----------------|----------------|
| Control (wheat 100%)| 33.69 ± 1.04\(^{a,b}\) | 0.77 ± 0.04\(^{c}\) | 21.82 ± 1.26\(^{b,c}\) |
| Cassava 15%         | 36.61 ± 1.08\(^{b,c}\) | 0.53 ± 0.56\(^{b,c}\) | 22.93 ± 0.20\(^{b,c}\) |
| Cassava 30%         | 35.89 ± 3.49\(^{a,b,c}\) | 0.12 ± 0.42\(^{a,b,c}\) | 23.38 ± 3.17\(^{c}\) |
| Cassava 45%         | 37.84 ± 1.15\(^{c}\) | 0.24 ± 0.46\(^{a,b,c}\) | 21.56 ± 2.07\(^{b,c}\) |
| Corn 15%            | 34.22 ± 0.50\(^{a,b}\) | -0.59 ± 0.63\(^{a}\) | 20.79 ± 1.29\(^{a,b,c}\) |
| Corn 30%            | 34.38 ± 2.83\(^{a,b,c}\) | -0.20 ± 0.44\(^{a,b}\) | 19.58 ± 2.01\(^{a,b}\) |
| Corn 45%            | 32.44 ± 0.57\(^{a}\) | -0.09 ± 0.55\(^{a,b,c}\) | 17.87 ± 1.14\(^{b}\) |

Note: Means in the same column with different letters (a, b, c) differ significantly (p≤0.05) by Duncan’s multiple range test

Snack that was substituted with 45% cassava flour has a higher L value than control snack. Nevertheless, the utilization of cassava flour as a substitution material has no effect neither on a* index nor on b* index. The opposite condition occurred in corn flour. The utilization of corn flour as a substituted material produced snack with higher intensity level in green than control treatment. Snack that was substituted with 45% corn flour has the lowest b* index (more yellow than other treatments). This condition probably influenced by carotene content in the corn flour. The color change in fried snacks may also related with the Maillard reaction, a non-oxidative browning process which caused by an interaction between the amine group with reducing sugar [7]. The high protein
content in the wheat flour might promote the brown color through the Maillard reaction during the frying process. Therefore, the higher level of wheat flour substitution will produce snacks with a brighter color.

3.2. Chemical characteristics of cassava leaves snack
Moisture content of snack that was substituted with cassava flour and corn flour were about 1.75 – 2.21% and 2.79 – 2.99%, respectively (Figure 2). The utilization of cassava flour as a substitution flour produced snack with lower moisture content. This condition probably had a connection with the initial moisture content of the flour itself and the moisture content of cassava-leaves as the main raw material.

Beside the initial moisture content of raw materials, water holding capacity of the flour was also could be affected the moisture content of the final product [8]. In this study, we presumed that the water-holding capacity of corn flour were relatively higher than cassava flour. Based on the data of several researches, the water holding capacity of cassava flour is ranged from 101 to 202% [9, 10], while corn flour and wheat flour are 617 and 778%, respectively [11]. The higher water-holding capacity allowed retaining more water molecules in snacks, and this resulted in higher moisture content [9].

![Figure 2](image_url)

**Figure 2.** The effect of cassava and corn flour substitution on the moisture content of the snacks

Effect of the utilization local flour (cassava and/or corn) on the protein content of snack was shown in Figure 3. Statistical analysis showed that snacks that substituted with cassava or corn flour at 15% have equivalent protein content with the control snack. This condition indicated that cassava and/or corn flour are potential to substitute the wheat flour without changing the nutrition of the final product.
Figure 3. The effect of cassava and corn flour substitution on the protein content of the snacks

In this study, the lipid content of snack that was substituted with corn flour was lower than snack that was substituted with cassava flour (Figure 4). Meanwhile, the lipid content of corn flour that was used in this study was higher than cassava flour. The lipid content of corn flour and cassava flour were 2.04 and 1.50%, respectively (data not shown). Whereas, the lipid content of wheat flour was 8.9% [12]. This condition indicated that there were other factors affected the lipid content of snack aside from the lipid of the substitution flour. The lipid content of fried snack can be influenced by several factors, including type and condition of fried ingredients, types of cooking oil, time, temperature, frying equipment, etc. [13, 14, 15].

Figure 4 showed that the higher level of flour substitution for the production of snack induced the increase of lipid content of the product. This phenomenon was related to the degree of expansion, which followed by the degradation in the specific surface area and the number of pores in the product during frying that was not enabled a sufficient space for oil absorption [16, 17].

Figure 4. The effect of cassava and corn flour substitution on the lipid content of the snacks

Some researchers [18, 19, 20] stated that the oil absorption in the product was affected by the initial moisture content of fried products. During the frying process, water diffuses inside the matrix and forms a path called capillary hole that would be filled by oil. As more moisture losses during the frying process, the oil (lipid) of the product will increase [20].
4. Conclusion
The flour from local commodities such as cassava and corn are potential to substitute wheat flour on the production of vegetable snack. Different types of substitution flour in the production of cassava-leaves snack have a significant effect on physicochemical characteristics of products, specifically hardness, color, moisture content, protein, and total lipid. The utilization of cassava and/or corn flour was potential to improve the physical characteristics of the snacks such as crispness and color. However, the overmuch substitution would produce undesired snacks, which have lower protein content and higher fat content. Therefore, the suggested level of substitution in producing cassava-leaves snack was 15%.

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