Fortification of Modified Cassava Flour (Mocaf) Cookies with Rich Nutrition Vegetable Powder

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Abstract. Modified cassava flour (mocaf) is made from fermented cassava. Mocaf can be made into delicious products but lacks in protein, fat, and mineral content. Thus, mocaf cookies need to be fortified with other ingredients such as moringa (*Moringa oleifera*), katuk (*Sauropus androgynus*), and kale (*Brassica oleracea* var. sabellica). This vegetable are rich in calcium (Ca), magnesium (Mg), potassium (K), iron (Fe), manganese (Mn) and zinc (Zn). The aim of this study to compare nutritional values mocaf cookies with an additional three-leaf powder of moringa, katuk, and kale. The moringa cookies have the highest fat (38.1±1.2%) and crude fiber content (1.4±0.15%). After that, kale cookies has the highest protein content were 5.08±0.58%. Then, the cookies with the highest potassium, calcium, and magnesium content are kale cookies (202.0±0.5; 82.3±0.5; 97.7±0.58 mg/100 g), followed by katuk cookies (198.0±1; 64.5±0.4; and 71.5±0.1 mg/100 g) and moringa cookies (169.0±0.1; 77.3±0.2; and 63.0±0.8 mg/100 g). Generally, aroma, taste and color of mocaf cookies with vegetable powder were still acceptable for consumption. In conclusion, the fortification of moringa, katuk, and kale leaf powder for mocaf cookies success to increase their nutritional values, such as proximate and mineral content of the cookies.

1 Introduction

Modified cassava flour (mocaf) is flour from cassava (*Manihot esculenta* Crantz) which was developed with the principle of fermentation by lactic acid bacteria [1]. Nutritional content of mocaf is almost equal with wheat flour thus mocaf can be used as wheat flour substitute. The energy content of 358 cal mocaf is similar to wheat flour that is 365 cal. The carbohydrate, protein, fat, iron, calcium and phosphorus content of mocaf is 88.6 g; 0.19 g; 0.02 g; 1.58 mg; 20.0 mg; and 7.0 mg [2].

Mocaf is very suitable to be used as cookies ingredient. Cookies hold an important position in snacks because of variations in taste, crispness and digestibility. They are ready to eat, easy and inexpensive food products, containing digestive principles and a very important diet [3]. Cookies are a widely consumed snack product, valued for their organoleptic nature, versatility, comfort, texture, and appearance [4]. Cookies are a medium for combining various food ingredients that are ideal for processing into nutrient-rich foods

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that are loved by children [5].

Cookies which are consumed widely by children, have been fortified with iron and other nutrients and are used to reduce the prevalence of child stunting in Indonesia. According to the findings of this study, fortification of cookies with moringa, katuk, and kale leaf powder is a highly effective method for increasing the nutrients in diet of children, due to its simplicity, low cost and feasibility. So it can be a suitable carrier for fortification. Moreover, due to its high availability, the cost of production becomes lower.

Moringa oleifera known as 'The Miracle Tree' or 'Tree for Life' because it has a high and complete nutrition [6]. The leaves are rich in minerals [7], vitamins [8] and other essential phytochemicals [9]. Iron content in moringa leaves were higher than other vegetables which is 17.2 mg / 100 g [10]. In addition, Moringa leaves also contain various kinds of amino acids, including amino acids in the form of aspartic acid, glutamic acid, alanine, valine, leucine, isoleucine, histidine, lysine, arginine, phenylalanine, tryptophan, cysteine and methionin [11].

Kale (*Brassica oleracea Acephala*) and katuk (*Sauropus androgynous*) are green leafy vegetables with a high content of nutraceuticals. These vegetables have been reported that content some nutrition and good for human health, namely vitamin C, phenolic, glucosinolates, dietary fiber [12], and protein [13]. Then, kale [12] and katuk [14] also contain micro-and macronutrients, such as iron, zinc, mangan, calcium, and magnesium. Furthermore, the fresh katuk leaves consist of ash, fiber, moisture, protein, and fat are 2; 1-2; 70-90; 3-8 and 1-4%, respectively [15].

Mocaf flour having a high energy content, but lacks protein, vitamin and mineral content, so mocaf cookies need to be fortified with other ingredients such as the leaf powder of moringa, katuk and kale. In this study, the effect of fortification mocaf cookies with rich nutrition vegetable powder (moringa, kale and katuk leaf powder) on the proximate content, mineral content and physical appearance of cookies was determined.

2 Materials and Methods

2.1 Processing of cookies

The materials used in this study were mocaf, wheat flour, moringa leaf powder, kale leaf powder, katuk leaf powder, soy flour, anchovy powder, margarine, sugar powder, egg yolks, milk powder, salts and vanili powder. The formulations for cookies making were mocaf (34.64%), margarine (29.70%), wheat flour (9.90%), sugar powder (9.90%), soy flour (2.48%), and anchovy powder (0.99%). In addition, 7.92% of egg yolks, 1.98% of milk powder, 0.5% of salts, and 0.5% of vanili powder. As a treatment, moringa leaf powder, kale leaf powder, katuk leaf powder were added as much as 1%. For a control, wheat flour without mocaf and fortification were used. All ingredients were weighed according to the percentage used.

The margarin and eggs were mixed well in a rubber bowl to a creamy consistency. The mocaf, vegetable leaf powder, sugar powder, soy flour, milk powder, and anchovy powder were mixed together then added to the creamy mixture and kneaded until a dough of elastic but not sticky consistency was obtained. Kneading continued for 5 mins to obtain a smooth, elastic dough. The dough was rolled out with a rolling pin and shaped with cookie cutter as desired. The dough was baked at 150 ºC for 15 minutes, allowed to cool and packaged well. The cookies were then analyzed for its proximate content, mineral content and physical appearance. Flowchart of cookies processing were shown in Fig. 1.

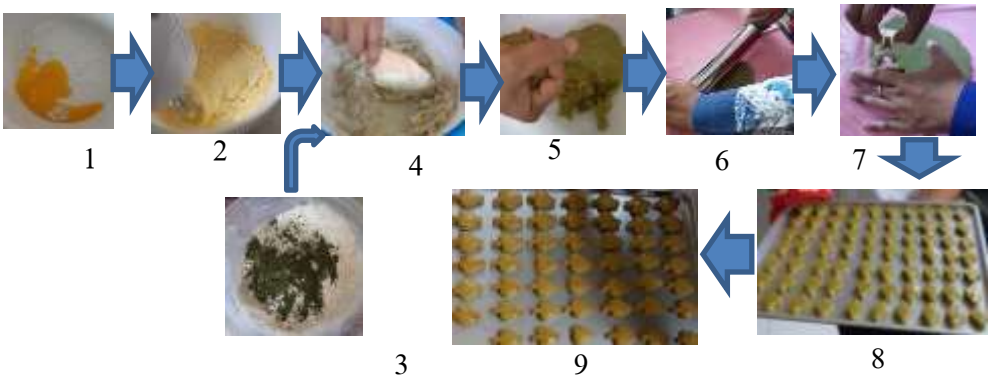

Fig.1. Flowchart of cookies processing: (1) Margarin and eggs; (2) Mixed; (3) Mocaf, vegetable leaf powder, sugar powder, soy powder, milk powder, and anchovy powder; (4) Mixed; (5) Kneaded; (6) Rolled; (7) Moulded; (8) Raw cookies; and (9) Cooked cookies.

2.2 Analysis

Moringa cookies, kale cookies, katuk cookies and control cookies were analyzed for proximate content, mineral content and physical appearance. Proximate content analysis performed was moisture, ash, crude fat, crude fiber and crude protein following the methods described [16]. While the mineral content analysis were Ca, Mg, K, Fe, Mn, and Zn. The mineral content using dry ash method the quantification was done by using Atomic Absorption Spectroscopy AAS (Model Agilent Technologies 200 series 280fs AA, Australia). The quantification was done by using AAS Flame, following the methods as described in [16]. The physical appearance of cookies is observed internally by team members for their color, aroma and taste.

2.3 Data analysis

The study was using Completely Randomized Design of experiment. Three replicates were run for proximate and mineral content analyses, while in physical appearance, replication is represented by number of panelists.

3 Results and Discussion

3.1 Proximate Analysis of Cookies

Proximate analysis data for control cookies and vegetable cookies can be seen in Fig. 2. Control cookies use wheat flour as raw material, while vegetable cookies use wheat flour and it substitute as raw material. The wheat flour substitute consists of mocaf and vegetable powder. Varieties of vegetable powder used were katuk, moringa and kale powder. The amount of each vegetable powder in cookies formulation is same for each type of cookies, which is 5% of the total powder used.

In Fig. 2, moisture content of each cookie's product ranges from 2.35-4.09%. Kale cookies has highest moisture (4.09 ± 0.44%) followed by katuk cookies (3.42±0.08%) and moringa cookies (2.35±0.13%). All product moisture content is still within the range of

values required in SNI 2973 Biscuits [17], which is not more than 5%. The maximum moisture content of 5% in cookies can prevent physical damage such as cookies becoming sluggish and losing their crispiness, as well as damage caused by microorganisms such as mold.

The difference moisture content of the product can be caused by various factors including the water content of the initial material and the processing process. During the cookie processing process, the thickness of the dough and the baking conditions (temperature and time) also affect the moisture content of the final product. Thinner cookies will take less time to cook, thus with the same baking time and temperature, thinner cookies will have a lower moisture content than thicker cookies. Another factor that is thought to affect the moisture content of the product is the water holding capacity of raw materials.

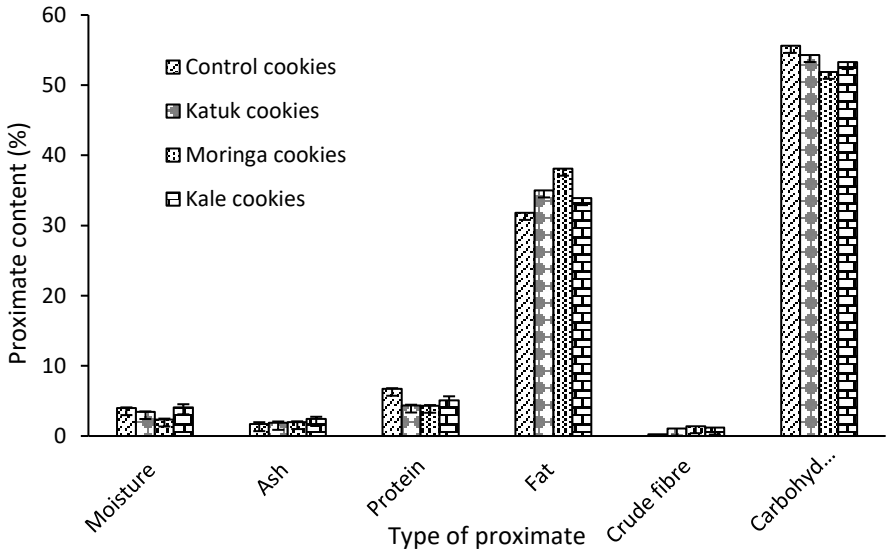

Fig. 2. Proximate content control, katuk, moringa and kale cookies

The ash content of all the cookies is in nearly range. Kale cookies has highest ash content (2.43±0.31%), followed by moringa cookies at 1.99±0.1% and katuk cookies at 1.88±0.19%. Control cookies have the smallest ash content, 1.69±0.28%. Ash is an inorganic substance left over from the combustion of an organic material [18]. The purpose of determining total ash including as parameters of the nutritional value of food ingredients and whether the processing process is good or not. The ash content of a material is closely related to the mineral content of the material. With controlled conditions and processing methods, it is expected that the difference in the ash content of the product is caused by the mineral content of the product. There was a tendency for cookies that received vegetable powder substitution treatment to have a higher ash content than control cookies. A significant difference in the ash content of kale cookies is expected because it has a higher mineral content than other cookies.

The value of protein content in the cookie products with the addition of vegetable powder ranged from 4.31±0.11 to 5.08±0.58% where the highest content was in kale cookies and the lowest was in moringa cookies. The protein content of control cookies was 6.74±0.07%, which was higher than cookies treated with vegetable powder. This is because control cookies only use wheat flour, while in vegetable cookies there are wheat flour substitutions of 60% mocaf and 5% vegetable powder respectively to the amount of flour used. The protein content in mocaf and vegetable powder given to the cookies is not as big as the substituted flour

content thus the final result is the protein content of the cookies is not as big as the control cookies. Of the three treating cookies with vegetable powder, kale cookies have met the quality requirements of SNI 2973 Biscuits [17].

The fat content of the cookies treated with vegetable powder was 33.9 ± 0.93% for kale cookies, 35±1.1% for katuk cookies, and 38.1±1.2% for moringa cookies. The fat content of control cookies was below vegetable cookies, namely 31.8±1.8%. This is thought that the fat to have come from the initial content of the raw materials used.

Crude fiber in vegetable cookies is up to 7 times higher than control cookies. Control cookies only have 0.23±0.01% crude fiber content while vegetable cookies have up to 1.4±0.15% crude fiber. The highest crude fiber content was found in moringa cookies at 1.4±0.15% followed by kale cookies at 1.21±0.13% and katuk cookies at 1.06±0.02%. The high fiber content is one of the advantages obtained from the substitution treatment of vegetable powder. Various benefits of fiber for the body include improving digestion, lowering cholesterol levels, helping control blood sugar, and preventing colon cancer [19]. The fiber content in cookies fulfills the quality requirements of supplement products for toddlers aged 6-59 months, under the thin category, namely a maximum of 5%.

Carbohydrates are a source of energy needed by the body for metabolism. In cookies products, the main source of carbohydrates comes from flour. There was a tendency for the carbohydrate content of the control cookies to be higher than the vegetable cookies according to the total amount of powder used in the making of the cookies. The carbohydrate content of the control cookies reached 55.6 ± 1.1% while the vegetable cookies were 54.3±0.6% for katuk cookies, 53.3±0.58% for kale cookies and 51.9 ± 0.6% for moringa cookies.

Based on these proximate data, it can be said that the advantages of vegetable cookies compared to control cookies is higher ash content (the highest in kale cookies) which indicates a higher potential for mineral content and a higher fat content which can provide nutritional value and calorie contribution for stunting toddlers. The moisture content of the vegetable cookies varied above and below the moisture content of the control cookies, but all of them were still within the requirements of SNI for Biscuits. Protein content of vegetable cookies (the highest in kale cookies) reaches 75% protein content of control cookies, which can be increased through formulation by adding other protein sources. Another advantage of vegetable cookies is the crude fiber content which reaches 7x (the highest in Moringa cookies) than the crude fiber content of control cookies which can aid human digestive process. Based on these data, it can be concluded that vegetable cookies have good nutritional value and have the potential to be developed further.

3.2 Mineral Content of Cookies

There are two types of minerals in Nature, namely macro-and micro minerals. The macro-minerals required above 100 mg/dl in the human body, such as sodium, calcium, phosphor, and chloride. In contrast, the micro minerals required below 100 mg/dl in the human body, such as iron, iodine, zinc, mangan, selenium, and sulfur [20].

The results obtained on mineral content of control, moringa, kale, and katuk cookies presented in Fig. 3. Results showed that the moringa cookies, kale cookies, katuk cookies have higher Fe, Ca, K, Mg and Mn contents than control cookies (Fig. 3). Addition of moringa, kale, and katuk leaf powder increased mineral content of cookies. In a similar study, there is an effect of moringa powder (*Moringa oleifera* L.) substitution of cookies on physical and organoleptic characteristics, proximate content, and iron level [21].

Kale cookies have the highest Ca, K, Mg, and Fe contents with values of 82.3±0.2, 202±0.5, 97.7±0.58, and 3.48±0 mg/100 g respectively while katuk cookies have the highest Mn content that is 0.75 mg/100 g. Control cookies contain the highest Zn (4.11± 0.001 mg/100 g), this is presumably because the cookies use wheat flour which has been fortified

with Zn.

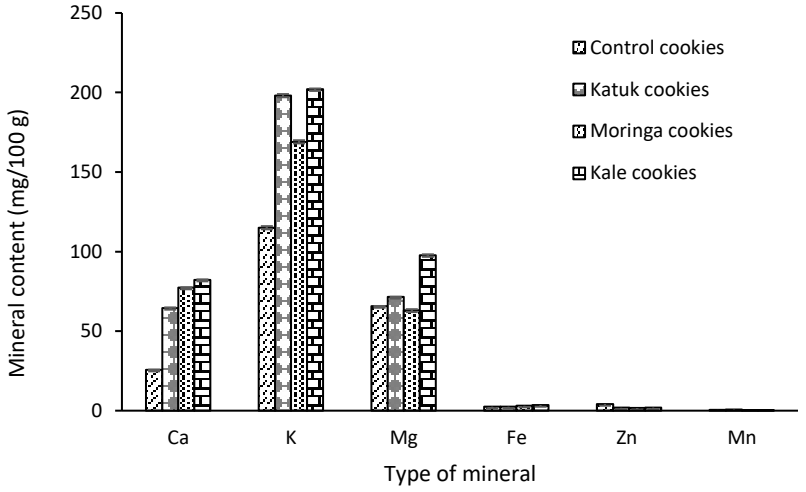

Fig. 3. Mineral content control, katuk, moringa and kale cookies

The addition of kale leaf powder has increased Ca, K, Mg and Fe content by 56.6, 87, 32, and 0.94 mg/100 g, respectively. Kale is a plant rich in essential minerals such as calcium, potassium, magnesium, manganese, copper and selenium [22]. The results were similar in a study cookie which is substituted with sweet potato and kale powders, up to 27%, providing calcium enrichment, antioxidants and an increase in nutrient content [23].

Substitution of katuk leaf powder has increased Mn levels in katuk cookies about 0.75%. According to the research of Petrus [24], katuk dry leaves contain Mn of 25.6 ± 05.8 mg / 100 g. It is suspected that the Mn content in katuk leaves is higher than other types of plants so that katuk cookies contain Mn content than other cookies.

The concentrations of these trace minerals in vegetables may vary depending on the inherent (varieties, maturity, genetics, and age) and environmental (soils, geographical locations, season, water source and use of fertilizers) conditions of plants and animals and on methods of handling and processing [25].

Macro and micro minerals have an important role in the body's metabolic processes. Minerals are nutrients or substances that play an important role in the body and are one of the determining indicators of health in the human body. Minerals are micronutrients that function for the process of growth, regulation, and repair of body functions [26].

3.3 Physical Appearance of Cookies

The original cookies, katuk, kale and moringa cookies were compared to their organoleptic tests, namely aroma, taste and color. The aroma of original cookies is still the most preferred because it doesn't smell of leaves, while for the cookies with leaf fortification the most smells of leaves are katuk cookies, followed by moringa cookies and kale cookies. In terms of the taste of the leaves, the cookies with the most taste of the leaves was the katuk cookies, followed by the moringa cookies and the least tasted the kale cookie. The organoleptic colors all looked good, the original cookies had a yellow color because they were not added with anything, while the katuk cookies had the darkest green color, followed by the moringa and kale cookies. Overall, all cookies are still acceptable for consumption. The appearance of all

the cookies can be seen in Fig. 4.

Fig. 4. Physical appearance (A) katuk, (B) kelor, (C) kontrol, and (D) kale cookies

4 Conclusion

Fortification of katuk, moringa and kale leaf powder in cookies substituted with mocaf succeeded in increasing the proximate and mineral content of the cookies. The cookies with the highest fat and crude fiber content are moringa cookies, followed by katuk and kale cookies. For the other proximate components, the control cookie remains the highest. The cookies with the highest potassium, calcium and magnesium content were kale, followed by katuk and moringa cookies, while for the iron, manganese and zinc components, the three leaves contained no significant difference. Organoleptically, the one with the most aroma, taste and green leaf was the katuk cookie, followed by the moringa and kale cookies.

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