Nutritional Value, Antioxidant Activity, Sensory Properties, and Glycemic Index of Cookies with the Addition of Cassava (*Manihot utilissima*) Leaf Flour

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Summary Cassava leaves contain albumin, fat, carbohydrates, vitamin A, vitamin B1, and fibers, thus having the potential to be used as an ingredient in production of cookies. The purpose of this research was to determine the optimum ratios between wheat flour, cassava puree and cassava leaves flour to produces cookies with good nutritional profile. This study was conducted as Completely Randomized Designs with five treatment, namely the ratios between wheat flour: cassava puree: cassava leaves flour (WF:CP:CLF) in grams of 50 : 50 : 0, 49 : 49 : 2, 48 : 48 : 4, 47 : 47 : 6 and 46 : 46 : 8. Each treatment was replicated thrice. Parameters observed were the nutritional content, sensory acceptance, antioxidant activity and glycemic index (GI) of the cookies. The data obtained were analysed with ANOVA, continued by LSD test at α=0.05 for treatment showed a significant effect. The result showed that the chemical characteristics of the cookies were 1.46–5.12, 0.23–2.10, 10.67–20.76, 1.20–4.26, 8.36–10.94 and 64.75–74.09% for moisture content, ash, fat, fibre, protein and carbohydrate, respectively. The energy and antioxidant activity (IC_{50}) of the cookies was at the range of 426.31–480.30 kcal/100 g and 151–200 ppm. The most preferred sample was the one with WF : CP : CLF of 49 : 49 : 2 with a GI value of 77.4. This study showed that cassava leaves flour has potential as an alternative ingredient in improving the nutrition profile of cookies production.

Key Words cassava leaves, cookies, nutritional, antioxidant, glycemic index

Food development based on food preferences has been a factor for food selection for thousands of years and is determined by genetic and environmental factors (*1*). Food development and food security on Dayak ethnic groups are strongly influenced by forest environmental resources. The use of cassava as a food source is very dominant after rice in Dayak ethnic groups in West Kutai Regency (*2*). Cassava also plays a big role in covering national food security (*3*). Cassava leaves are lower in calories. It provides the satiety effect. The cassava leaves assists in digestion and helps to overcome the constipation. It also helps to relieve headaches, cold medicine, worms, rheumatism, ulcers, diarrhea and enhance stamina (*4*). Cassava leaves in Indonesia are used as vegetables, in the form of boiled cassava leaves and mashed vegetables. All Padang restaurants and local Indonesian restaurants generally provide cassava leaves. Mashed cassava leaves, especially for ethnic Batak, Dayak, Toraja and others.

Cassava tubers containing energy amounting to 160 kcal, carbohydrates 38.06 g, protein 1.36, total fat 0.28 g and fiber 1.8 g (5). Cassava can also be grown in other food products, analog rice or cassava rice which have a low glycemic index (*6*). In addition to the tuber parts of cassava which have good benefits for human health, cassava leaves contained a high level of crude protein (29.3–32.4%), fat, carbohydrates, vitamin A, vitamin B1, flavonoids, triterpenoids, saponins, tannins and vitamin C (*7*, *8*) The methanol extract from the leaves and tubers of cassava plants measured the percentage of inhibitory power using the free radical reduction method with DPPH reagents (2,2-diphenyl-1picrylhydrazyl) at a concentration of 100 ppm. The antioxidant test results showed that the portion of the buds of cassava leaves had the highest inhibitory power of 88.09% and IC_{50} of 45.16 ppm (*9*). Antioxidant activity (IC_{50}) of cassava leaves extract by methanol, water, ethyl acetate and n-hexane are 50.87, 24.79, 37.40 and 122.95 ppm, respectively (*10*).

Processing cassava leaves into flour will support the use of cassava leaves in various manufacturing of food products, e.g. cookies. Mixtures and processing methods are expected not to reduce the nutritional value (*11*). This study aimed to determine the effect of cassava leaves flour in the formula of composite materials (wheat flour and cassava puree) on nutritional value, sensory characteristics and antioxidant activity of cassava leave (CL) cookies. Glycemic index of the CL cookies was also determined.

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Table 1. Effect of addition of cassava leave (CL) flour on nutrition content (% w/w) of CL cookies.

Nutrition	(Wheat flour: cassava puree: cassava leaf flour) (g)				
	50 : 50 : 0	49 : 49 : 2	48 : 48 : 4	47 : 47 : 6	46 : 46 : 8
Water Content (%)	3.39±0.81	2.58±0.53	4.07±0.15	4.83±0.09	5.12±0.16
Ash content (%)	1.73±0.12	1.80±0.26	1.56±0.19	1.46±0.15	1.63±0.25
Fat content (%)	20.76±0.25	12.60±0.20	12.13±0.15	11.50±0.20	10.67±0.15
Protein content (%)	9.13 ± 0.41^{c}	9.15 ± 1.29^{b}	9.35 ± 0.45^{b}	9.74 ± 0.55^{ab}	10.94 ± 0.88^{a}
Fiber content (%)	1.20 ± 0.10^{e}	2.10 ± 0.10^{d}	2.43 ± 0.15^{c}	3.27 ± 0.15^{b}	3.75 ± 0.15^{a}
Carbohydrate (%)	64.75 ± 1.14^{c}	73.86 ± 1.87^{a}	73.09 ± 1.46^{a}	72.28 ± 0.66^{ab}	71.64 ± 1.07^{b}
Energy (kcal)	480.30 ± 7.49^{a}	445.47 ± 2.08^{b}	438.07 ± 0.52^{c}	431.60 ± 1.57^{cd}	426.31 ± 181^{d}

CL cookies were prepared in 100 g composite flour basis. Data ($\bar{x}\pm$SD) were calculated from 3 replications. Data were analysed by ANOVA continued by Tukey test ($p=0.05$). Data within the same row followed by different letter are significantly different ($p<0.05$).

MATERIALS AND METHODS

Materials. Cassava and cassava leaf (CL) of Gajah variety were obtained from the Village of Bangun Rejo L3 Tenggarong. Margarine, low protein flour, baking powder, eggs, refined sugar were obtained from the local mini-market. DPPH (1,1-diphenyl-2-picrylhydrazyl) and other chemicals for proximate analysis were provided by Merck.

Experimental design. A single factor experiment (the composition of composite material) arranged in Completely Randomized Design with five treatments and three replications was conducted in this study. The composite flour composition of wheat flour (WF), cassava puree (CP) and cassava leaf flour (CLF) in the form WF : CP : CLF were 50 : 50 : 0, 49 : 49 : 2, 48 : 48 : 4, 47 : 47 : 6) and 46 : 46 : 8 in a total of 100 g composite flour.

Preparation of cassava puree and CL flour. Cassava tubers were stripped of skin then washed followed by steaming for ±30 min. The steamed cassava tubers were crushed using mortars and pestles to puree form and ready to be used.

Young CL (up to three levels down) were washed and drained followed by drying in the oven at 55˚C for 16 h. The dried cassava leaf then pulverized by blender followed by sieving using 80 mesh siever.

Making CL cookies. A 40 g margarine and one egg yolk were mixed, then added by 50 g sugar, 0.25 g baking powder, 100 mg vanilla powder, and composite flour (WF : CP : CLF) while continued mixing until smooth. After that, a small amount of dough was taken placed on a flat pan and formed, then baked in an oven with a temperature of 140˚C, for 30 min.

Determination of nutritional value and anti-oxidant activities. The analysis carried out includes moisture content, Fat Content, Fiber, and Protein (*12*); Ash content, Carbohydrate Level Calculation by difference; Total Energy Measurement (*13*); Test Antioxidant Activity with DPPH (*14*).

Sensory test. The hedonic scale test (preference) in this cookies study uses 5 rating scales with rather 20 trained panelists. Hedonic quality test was done by given a score for color attributes, 5=very green, 4=green, 3=greenish brown, 2=brown, 1=brownish yellow. Aroma; 5=aroma of cassava leaves flour, 4=aroma of flour and cassava leaves flour, 3=aroma of cassava, 2=aroma of flour, 1=very flavorful of flour. Taste; 5=very much cassava leaves, 4=taste of cassava leaves, 3=rather taste of cassava leaves, 2=cassava taste, 1=flour taste. The texture: 5=very crunchy, 4=crunchy, 3=slightly crunchy, 2=not crunchy, 1=not crunchy very much.

Glycemic index of CL cookies. Blood sampling was taken on the first day by giving cookies to 10 subjects who had undergone full fasting (except water) for one night (around 8:00 p.m. until 8:00 a.m. the next morning) Blood collection was done with an interval of 30 min for 5 times (0, 30, 60, 90 and 120 min.). Then intermittent 3 d after the first blood collection, in the same way then the second blood is taken by giving white bread as a reference food. Blood glucose was measured by Accu Check Active Glucometer. Blood samples obtained on the surface of the skin after a small minor injury using a special lancet, are touched on the sensor slit at the end of the test strip that has been installed on the digital detector so that the glucose level of the sample is read. IG values are calculated by comparing the area under the curve multiplied by 100 (*15*).

RESULTS

Nutrition value of CL cookies

The addition of cassava leaf (CL) flour affected significantly ($p<0.05$) on protein, fibre and carbohydrate content of CL cookies (Table 1). The more addition of CL flour decreased the energy levels of the cookies but increased the fibre content.

Sensory properties of CL cookies

The average hedonic test results and the hedonic quality of wheat flour formulation cookies, cassava tubers and cassava leaf flour are presented in Table 2.

Table 2. Hedonic and hedonic quality of cookies with added ratio of wheat flour, cassava puree and cassava leaf flour.

Sensory Properties		Wheat flour: cassava puree: cassava leaf flour (g)				
		50 : 50 : 0	49 : 49 : 2	48 : 48 : 4	47 : 47 : 6	46 : 46 : 8
Hedonic	colour	4.68 ± 0.27^{a}	4.40 ± 0.41^{ab}	3.96 ± 0.35^{bc}	3.54 ± 0.17^{c}	3.49 ± 0.33^{c}
	aroma	4.36 ± 0.15^{a}	4.16 ± 0.34^{a}	3.79 ± 0.07^{b}	3.47 ± 0.03^{c}	3.19 ± 0.05^{c}
	texture	4.04 ± 0.25^{a}	3.70 ± 0.57^{ab}	3.58 ± 0.35^{ab}	3.13 ± 0.06^{bc}	2.95 ± 0.06^{c}
	taste	4.61 ± 0.11^{a}	4.43 ± 0.41^{a}	4.20 ± 0.20^{a}	3.51 ± 0.16^{b}	3.31 ± 0.17^{b}
Quality hedonic	colour	1.01 ± 0.02^{c}	2.05 ± 0.22^{b}	2.30 ± 0.42^{b}	2.95 ± 0.14^{a}	2.95 ± 0.22^{a}
	aroma	1.42 ± 0.17^{d}	2.10 ± 0.14^{c}	2.50 ± 0.24^{b}	2.88 ± 0.17^{a}	3.08 ± 0.06^{a}
	texture	4.09 ± 0.18^{a}	3.77 ± 0.42^{ab}	3.43 ± 0.51^{bc}	3.08 ± 0.29^{c}	3.03 ± 0.05^{c}
	taste	1.26 ± 0.07^{c}	2.12 ± 0.17^{b}	2.43 ± 0.33^{b}	2.85 ± 0.13^{a}	3.19 ± 0.15^{a}

Data ($\bar{x}\pm$SD) were calculated from 60 data. Data within the same row, followed by the same letter are significantly different (Tukey test, $p<0.05$). Hedonic scale 1–5 was for very dislike to very much like. Quality hedonic scale 1–5 for colour was for brownish yellow, brown, greenish-brown, green and very green; aroma was for wheat flour aroma very much, wheat flour aroma, cassava aroma, cassava leaves flour aroma; taste for taste of wheat flour, taste of cassava, taste mild of cassava leaves, taste of cassava leaves, taste very much of cassava leaves; texture for not crunchy very much, not crunchy, slightly crunchy, crunchy, very crunchy.

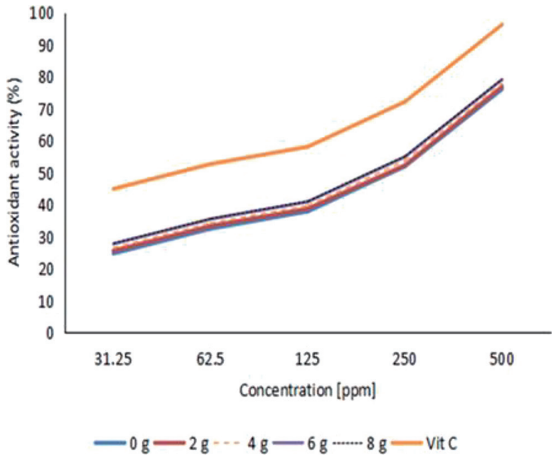

Fig. 1. Antioxidant activity of CL cookies with formula (46 : 46 : 2).

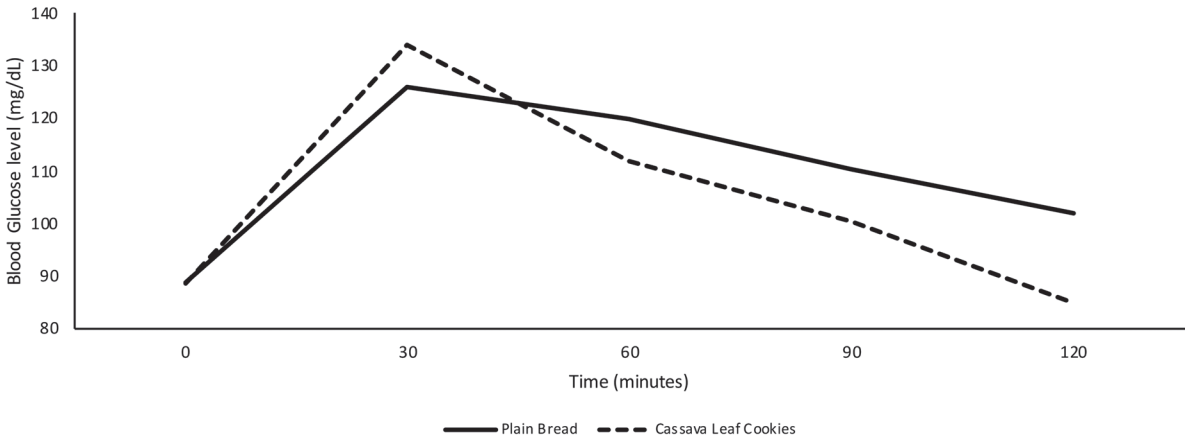

Fig. 2. Respondent's blood sugar response after consumption of of CL cookies with formula (46 : 46 : 2) and plain bread.

Antioxidant activity of CL cookies

The addition of CL flour in the cookies formula affected insignificantly ($p>0.05$) on the IC_{50} of antioxidant activity of the CL cookies. The IC_{50} of antioxidant activity was in the ranged of 244.36 ± 37.31 to 214.32 ± 17.88 ppm (Fig. 1).

Blood glucose response and glycemic index of CL cookies

Using the formula of the most preferred CL cookies preparation (46 : 46 : 2), the glycemic index (GI) of the CL cookies belongs to high GI, i.e. 77.4. The results showed of the response of the blood sugar of respondents who consumed cassava leaf cookies are presented in the following Fig. 2.

Glycemic index values are calculated by comparing the area under the curve multiplied by 100. The calculation results show the GI of cassava leaf cookies at 77.4.

DISCUSSION

The nutritional profile of CL cookies

Cassava leaf (CL) cookies have lower water content than Indonesian National Standard (SNI) cookies provisions of 2.58%. However, the water content in CL cookies with an addition below 8 g of cassava leaf flour still meets the requirements set by the Indonesian National Standard, which is less than 5%. But in the treatment of the addition of 8 g of cassava leaf flour the results obtained exceeded the SNI of 5.12%, the increase in water content was estimated because cassava leaves had water binding properties so it was not easy to evaporate, cassava leaves had high fiber content, and binding ability the water is also getting higher. The high water content of cassava leaves cookies is also influenced by the water content of CL around 62.50 g per 100 g of CL.

CL cookies obtained ash content ranged from 1.46 to 1.80%. CL flour addition had no significant effect on the ash content of CL cookies. According to standard SNI (*16*) maximum of ash content is 1.6%. The ash content in CL cookies still exceeds the specified standards, this is due to the addition of CL flour, which has a high ash content of 7.60% (*17*). The mineral content of CL flour, i.e. calcium, florin and iron are 165, 54 and 2 mg per 100 g which are higher than that of minerals in wheat flour (*18*).

The more the CL are added to each treatment, the lower the fat content in the CL cookies. The fat content that was still in accordance with the Indonesian National Standard with the fat content of cookies min. 9.5% w/w. Fat content in CL is 12.98% (*17*). Addition of CL flour had significantly affected the crude fibre content of CL cookies, because of CL had high fibre of 15.12% (*17*). According to SNI, the crude fibre content of cookies is max. 0.5% w/w. The addition of CL flour was able to increase the dietary fibre content in the product as much as 8 times. This showed that CL flour has high dietary fibre and could be used as an ingredient to increase dietary fibre levels in products to prevent various diseases such as high blood pressure, heart disease and diabetes mellitus.

The increase in protein content of CL cookies occurred with the addition of CL flour. CL had a protein content of 27.51%, in other case wheat flour had a protein content of 8% w/w (*17*). CL cookies still fulfil the SNI (*15*) cookies standard which is above 70%. The addition of CL flour decreased energy levels of CL cookies, this is caused by the energy content of cassava leaves, which is only 73 kcal (*18*). The lower energy level of CL cookies is 426.3 kcal per 100 g. According to SNI (*16*) cookies have a standard of minimum 400 kcal/100 g.

Sensory characteristics of CL cookies

The results of this study indicate that the addition of CL flour significantly affected the colour change of CL cookies. The more CL flour added, the greener the colour of the CL cookies produced, which came from chlorophyll from cassava leaves (*18*). The distinctive aroma of strong CL as the concentration of CL flour is added is influenced by the presence of phenol compounds in CL. CL is a part of the vegetable type that contain phenol, where the distinctive aroma of cassava leaves is produced from phenol compounds (*7*, *19*). The more cassava leaf flour added, the crisper the texture of the cookies produced.

The addition of CL flour increased the CL flour aroma of the CL cookies, which then decrease the taste quality of CL cookies due to the stronger taste of CL. Tannin may responsible for the decreasing of the CL cookies taste (*20*).

Antioxidant activity of cassava leaf cookies

The antioxidant activity of cookies showed that ranged with IC_{50} 244.36 to 214.32 ppm, this indicates CL cookies have weak antioxidant activity, because they have an IC_{50} value of more than 200 ppm (*21*). It was due to the heating process and relatively low concentration of cassava leaf flour added. Antioxidants are compounds that are susceptible to oxidation in the presence of effects such as light, heat, metal peroxide or directly react with oxygen so that the value of antioxidant activity decreases during the heating process (*22*). The antioxidant activity of cassava leaves had the highest inhibitory 88.09% and IC_{50} of 45.16 ppm (*9*). Antioxidant activity (IC_{50}) of methanol extract cassava leaves 50.87 μg/mL, water fraction 24.79 μg/mL, ethyl acetate fraction 37.40 μg/mL and fractions n-hexane 122.95 μg/mL (*10*).

Blood glucose response and glycemic index of CL cookies

The blood sugar of the fasting respondents' at 0 min. before consuming CL cookies was at an average of 88.6 mg/dL and increased at 30 min after consuming CL cookies to 133.9 mg/dL, while after consuming food reference plain bread, the blood sugar increased to 125.9 mg/dL. This result in accordance with 30 min after consuming rice (*2*), rice analogue (*6*), cereal lepiu 94.67 mg/dL, and commercially cereal 121.17 mg/dL (*23*). This shows that blood glucose is rapidly increasing after consuming food.

The glycemic index of CL cookies is 77.4, which is higher compared to the GI of plain bread, i.e. 71.00. It means that the CL cookies are categorized to high GI

(>70). It may cause the addition of 50 g refined sugar by the CL cookies production, which influences the increase in glucose levels in the blood of the respondents. In other study showed the higher the amylose content of food, the lower the GI, amylose content of black rice (25.49), brown rice (21.99), and brown rice (*14*, *24*). CL cookies could be consumed as energy cookies due to the energy content of cassava leaf cookies ranging from 426.3 kcal to 480.3 kcal/100 g greater than the standard cookies 400 kcal/100 g.

CONCLUSION

The addition of cassava leaf (CL) flour decreased the calories but increased the fibre content of cookies. The addition of CL flour affected insignificantly ($p>0.05$) on antioxidant activity, but affected significantly ($p<0.05$) the hedonic and hedonic quality of the colour, aroma, texture and taste of cassava leaf cookies. Antioxidant activity of CL cookies showed a weak antioxidant activity with IC_{50} values of 244.36–214.32 ppm. The CL cookies with the preferred formula (addition of CL flour of 2 g) showed a high glycemic index of 77.4.

Disclosure of state of COI

No Conflict interest tobe declare.

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