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NUTRIENT AND ANTINUTRIENT COMPOSITION OF DIFFERENT VARIETY OF CASSAVA (*Manihot esculenta Crantz*) LEAVES

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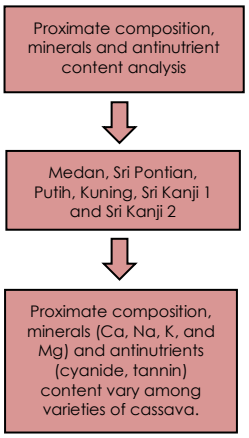
Graphical abstract



Abstract

The aim of this study was to determine the nutrient and anti-nutrient composition of six varieties of cassava leaf namely Medan, Sri Pontian, Putih, Kuning, Sri Kanji 1 and Sri Kanji 2. Proximate composition, minerals, cyanide and tannin content were analyzed. The results obtained showed that composition of nutrients and antinutrients in cassava leaves is different among the varieties. Cassava leaf of variety Medan has significantly high moisture content, while Sri Pontian has significantly high fibre content and Putih has significantly high content of protein compared to the other varieties. Highest ash content was found in both Putih and Sri Kanji 1 variety, while highest lipid was observed in both Sri Pontian and Sri Kanji 2. Both Medan and Sri Kanji 1 varieties showed significantly high in carbohydrate content. Among the varieties, Sri Pontian has the highest Ca content while Sri Kanji 1 has the highest Na content. Variety Kuning and Sri Kanji 1 have similarly high content of K, while Mg was found to be highest in both Medan and Sri Kanji 1 variety. For anti-nutrients composition, both cyanide and tannin were found to be significantly high in Sri Pontian variety compared to the other varieties. This study showed that cassava leaves has appreciable amount of nutrients and minerals that can be a good source of nutrients in a diet. However, proper pretreatments must be employed prior to consumption to reduce the anti-nutrients content in the leaves.

Keywords: Cassava leave, proximate composition, cyanide; tannin

1.0 INTRODUCTION

Cassava (*Manihot esculenta* Crantz) plant comes from the family of *Euphorbiceace* also known as yucca, manioc and tapioca. In many tropical and subtropical countries, especially in West Africa, cassava is the major staple crop. It is the forth supply of energy after rice, maize and sugar cane [1][2]. Cassava plant can grow in poor soil and survive for a long time without water and still retain its nutritional value. Thus makes it an important famine reserve crop and could become a source of food security in areas of low rainfall [3]. The edible parts of cassava plants are its tubers and leaves. Cassava tubers or root are rich in carbohydrate but deficient in protein, minerals and vitamins, while cassava leaves contain significant amount of dietary protein, minerals and vitamins [4]. The protein, fat and minerals content in cassava leaves is said to be higher than legumes and leafy legumes, except for soybean [5]. Calcium is reported as the highest concentration mineral in cassava leaves [3]. Other minerals that are rich in cassava leaves were Mg, Fe, Mn and Zn. Ascorbic acid and vitamin A were also found present in cassava leaves.

Both cassava tubers and leaves contains antinutritional factor such as cyanide, oxalate, phytate, tannin and trypsin inhibitor. Their presence in food causes interference to the absorption of nutrients. Among the antinutrients present, cyanide is

the most toxic compound that restricts the consumption of cassava tubers and leaves [5], [6].

According to a study, cassava leaves contain 15 to 20 times more cyanide than the tubers [7]. Therefore, cassava leaves were not widely used as a food source as compared to the tuber part, which was produced into varieties of food products. Moreover, cassava leaves also lack in acid amino methionine and cysteine, which are required to detoxify the cyanogen in human body [7]. Nevertheless, a proper pre-treatment process can reduce the content of anti-nutrients present in cassava leaves before it can be safely consumed. There are several techniques that can be used to reduce the content of antinutritional factor on cassava leaves such as sun drying, boiling, steeping, steaming and pounding. These different processing techniques would results in different degree of effectiveness on removing the anti-nutrients.

Variety of cassava plant may play an important role in the production of various food products since the nutrients and antinutrient composition vary from one variety to another. Generally, cassava can be divided into two types: bitter and sweet. Both types have different usage and applications in industry. The bitter type is mostly used in production of starch and animal feed while the sweet type are usually used for making snacks or eaten directly after frying or boiling. In Malaysia, there are about 80 varieties of cassava plant developed from tissue culture studies by MARDI [8].

Many studies have been conducted on cassava leaves and tubers, however these studies were mostly conducted based on the varieties of cassava grown in Indonesia, Thailand, Nigeria and other African countries. So far, studies on the nutrients and anti-nutrient present in the varieties of cassava grown in Malaysia are still scarce. Therefore, a study on these compositions is needed for future references. The objective of this study is to determine the proximate, minerals and antinutrients composition of different variety of cassava leaves.

2.0 EXPERIMENTAL

2.1 Raw Materials and Chemicals

Cassava leaves from six different varieties (Medan, Sri Pontian, Putih, Kuning, Sri Kanji 1 and Sri Kanji 2) were collected at MARDI, Serdang. The variety of Medan, Sri Pontian, Putih and Kuning are the sweet variety while Sri Kanji 1 and Sri Kanji 2 are the bitter variety. Analytical grade chemicals and standards used were purchase from Merck Sdn. Bhd., Selangor, Malaysia.

2.2 Preparation of Sample

The cassava leaves were washed using clean water to remove dust and dirt. The leaves were dried at 60 °C for 12 hours in drying cabinet, ground to powder form and then stored in plastic container at room temperature.

2.3 Proximate Analysis

Proximate analysis consists of moisture, crude protein, crude lipid, crude fibre and ash content was conducted according to AOAC standard method [9]. Carbohydrate content was determined by difference by subtracting the total percentage of moisture, crude protein, crude fibre, crude lipid and ash.

2.4 Determination of Minerals

Content of selected minerals (Ca, K, Mg and K) were determined by wet digestion method and measured using ICP-OES (Optima 5300 DV, Perkin Elmer Inc., USA).

2.5 Determination of Cyanide

The cyanide content was determined using the alkaline picrate method [10]. The absorbance value was taken using spectrophotometer (UVA-160921, Helios-α, Thermo Scientific, England) at 490 nm and cyanide content was determined against standard curve.

2.6 Determination of Tannin

Tannin was measured by spectrometric method [11]. The optical density was read at 700 nm using spectrophotometer (UVA-160921, Helios-α, Thermo Scientific, England). Concentrations of tannin in sample were calculated based on the tannic acid standard curve.

2.7 Statistical Analysis

All data was expressed as mean ± standard deviation. The data was analyzed using one-way Analysis of Variance (ANOVA) in the IBM Statistical Package for the Social Science (SPSS) program. Significance difference ($p>0.05$) was calculated using Duncan's new multiple range test.

3.0 RESULTS AND DISCUSSION

3.1 Proximate Composition

The proximate composition of different variety of cassava leaves is shown in Table 1. In general, carbohydrate is the highest component in cassava leaves followed by protein. Other components such as crude fiber, moisture, crude lipid and ash were found to vary according to the variety. Moisture content of Medan which is the sweet variety were significantly higher than other varieties followed by Sri Kanji 2, Sri Pontian, Kuning, Putih and the lowest is bitter variety of Sri Kanji 1. A study [12] found that

cassava leaves from local variety has moisture of 67.78% that is higher than this study. Other study found that moisture content in tuber of sweet variety is in within range of 0.82% to 12.3% and for bitter variety is 14% to 9.6% [10], [13].

Table 1 Proximate composition of different variety of cassava leaves

	Moisture (%)	Protein (%)	Crude Fibre (%)	Ash (%)	Crude Lipid (%)	Carbohydrate (%)
Medan	11.60±0.25^{a}	22.47±0.13^{d}	9.160±0.13^{e}	4.11±0.58^{c}	3.84±0.15^{c}	48.80±0.71^{a}
Sri Pontian	6.09±0.01^{c}	21.51±0.16^{e}	15.61±0.26^{a}	5.07±0.05^{b}	9.25±0.28^{a}	42.45±0.61^{c}
Putih	5.24±0.08^{d}	30.31±0.14^{a}	12.47±0.27^{c}	5.73±0.02^{a}	5.03±0.07^{b}	41.21±0.22^{d}
Kuning	5.89±0.02^{c}	28.56±0.17^{b}	12.19±0.48^{c}	5.12±0.15^{b}	4.73±0.13^{b}	43.49±0.34^{b}
Sri Kanji 1	5.05±0.03^{d}	25.81±0.07^{c}	10.54±0.22^{d}	6.16±0.09^{a}	3.86±0.22^{c}	48.57±0.09^{a}
Sri Kanji 2	7.33±0.04^{b}	28.73±0.31^{b}	14.72±0.07^{b}	4.93±0.02^{b}	9.10±0.15^{a}	35.17±0.22^{e}

Different alphabets indicate significant different at p<0.05 between sample.

Table 2 Minerals content of different variety of cassava leaves

	Ca	K	Mg	Na
		mg/100g		
Medan	890.30±0.67^{d}	1120.11±0.22^{e}	406.11±0.35^{a}	41.12±0.07^{c}
Sri Pontian	1182.00±0.04^{a}	1421.08±0.06^{d}	244.61±0.01^{c}	28.51±0.01^{d}
Putih	542.80±0.02^{c}	1552.03±0.20^{c}	248.83±0.01^{c}	38.21±0.02^{c}
Kuning	657.90±0.05^{c}	2190.15±0.28^{a}	341.04±0.03^{b}	47.22±0.01^{b}
Sri Kanji 1	781.00±0.01^{b}	2234.01±0.26^{a}	400.80±0.62^{a}	61.88±0.08^{a}
Sri Kanji 2	904.20±0.06^{d}	1621.21±0.38^{b}	183.75±0.01^{d}	23.66 ±0.04^{e}

Different alphabets indicate significant different at p<0.05 between sample.

This observation showed that the moisture content of sweet variety is higher than the bitter variety. Cassava leaf has been reported to have high content of protein. The protein value obtained from all the varieties was within the range of 21.52 to 30.31%. Variety Putih showed the highest protein content but the amount was lower than reported value by other study [3], which range from 27.2% to 33.8%. Other researcher obtained 33.83% of protein content [14]. Comparatively, protein in cassava leaves was found to be higher than other edible plant leaves such as *Morianga oleifera* with 17.01% [13] and sweet potatoes 24.85% [14].

Significant difference in crude fiber content was observed between variety except for Putih and Kuning, which showed no significant difference. Variety Sri Pontian has highest crude fiber (15.61%±0.26) while Medan has the lowest (9.16%±0.13). The crude fibre content range obtained was comparable to the range of 19% to 5.26% reported by other study [14] [16].

Both variety of Sri Pontian and Sri Kanji 2 showed the highest lipid content. No significant difference was observed between Putih and Kuning variety, while Sri Kanji 1 and Medan have the lowest lipid content. The value obtained is comparable to a study [3], which reported 8.6% to 10% crude lipid in cultivated cassava leaves. However, this value is higher compared to other plant leaves such as Chinese potato leaf and sweet potato leaf with 0.9% and 4.90% respectively [15] [14].

Highest value of ash was observed in Sri Kanji 1 and Putih variety followed by Kuning, Sri Pontian, Sri Kanji 2 and the lowest is Medan variety. The amount obtained was slightly lower than other study, which reported ash content within range of 7.9% to 8.7% [3]. The ash content reflects the mineral composition of cassava leaves. It is well known that ash content is highly dependent on the soil and area of plantation.

Carbohydrate content in Medan and Sri Kanji 1 was found highest compared to the other varieties. This amount was also higher compared to 44.7% to 46.1% reported by other study [3]. Compared to other plant leaves, carbohydrate content in cassava leaves is lower than sweet potatoes leaf (51.95%) [14]. Sri Kanji 2 has the lowest carbohydrate content (35.18%±0.22) but comparable to the amount reported by other study [13].

3.2 Minerals Composition

Selected minerals (Ca, K, Mg and Na) were analyzed and the results are shown in Table 2. In general, the highest mineral found in all variety of cassava leaves is potassium which range between 2234 to 1120 mg/100g, followed by calcium from 1182 to 542

mg/100g, Mg from 406 to 183 mg/100g and finally Na between 61 to 23 mg/100g. Mg was found highest in Medan and Sri Kanji 1 variety, Ca was highest in Sri Pontian, Na was highest in Sri Kanji 1 and K was found highest in Kuning and Sri Kanji 1. Values obtained from this study were considerably lower than reported in other study that obtained between 1802 to 2905 mg/kg [3].

3.2 Anti-nutrients Composition

Table 3 shows the content of cyanide and tannin in all varieties analyzed. Significant difference was observed between cassava varieties in term of cyanide content. The results showed that the level of toxic substance cyanide were higher in Sri Kanji 1 followed by Sri Pontian, Sri Kanji 2, Medan, Kuning and Putih. These values also point out that the cassava of bitter variety contained higher amount of cyanide. Similar observation was also reported by other study [9] [11]. However, this value is lower compared to the reported value of 270 mg/Kg [3].

Table 3 Anti-nutrient composition of different variety of cassava leaves

	Cyanide (mg/100g)	Tannins (mg/100g)
Medan	12.66±0.40^{d}	8.37±0.05^{b}
Sri Pontian	18.16±0.18^{b}	10.05±0.07^{a}
Putih	11.29±0.19^{e}	7.16±0.05^{dc}
Kuning	11.36±0.18^{e}	7.02±0.08^{d}
Sri Kanji 1	19.29±0.19^{a}	5.74±0.10^{e}
Sri Kanji 2	13.52±0.67^{c}	7.19±0.13^{c}

Different alphabets indicate significant different at $p<0.05$ between sample.

The amount of cyanide observed has exceeded the limitation of recommended cyanide level in food (10 mg HCN equivalent/kg dry weight) that means that the leaves are not to be eaten raw. Consumption of cyanide may cause acute or chronic cyanide toxicity and neuropathy [18]. According to a study [8], cyanide content in cassava tuber was lower than cassava leaves with only 0.4 mg/100g to 0.65 mg/100g. It was reported that cyanide content in leaves is 6 times higher than in the roots [12].

For tannin content, Sri Pontian showed the highest composition of 10.05 mg/100g±0.08 and the lowest tannins content is in Sri Kanji 1 with 5.75 mg/100g±0.11. This value is lower than the reported value, which obtained 6.9 g/100g to 15 g/100g in raw cassava leaves [18]. Other study, reported much lower tannin content of 10.2 mg/kg to 16.0mg/kg [3]. Presence of tannins can interfere with absorption of iron and other minerals and has capability to bind and precipitate proteins that leads to decreasing in digestibility [19]. Content of anti-nutritional factor can be lowered by conducting some pretreatment prior to consumption such as boiling, drying or soaking [18].

4.0 CONCLUSION

It can be concluded that cassava leaves of different variety has different amount of nutrients and anti-nutrients content. This study showed the potential of producing nutritional food products from cassava leaves by utilizing variety, which has higher nutrients and lower anti-nutrients. Further study can be conducted to determine the suitable method of pretreatment necessary to eliminate the anti-nutrients while maintaining the nutrient content.

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