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REVIEW ARTICLE

A REVIEW: EFFECT OF TEMPERATURE TO ANTIOXIDANT ACTIVITY AND HCN LEVEL IN CASSAVA (*MANIHOT ESCULENTA* CRANTZ) LEAVES

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ABSTRACT
Cassava Leaves (*Manihot esculenta* Crantz) is one of the food resources that many people consume as vegetables in some regions. People believe that it has natural antioxidant compounds such as phenolics and flavonoids. Also, it contains HCN elements known as toxic compounds. However, HCN levels can be reduced by dry heating and boiling. Phenolics and flavonoids are not resistant to heating and are easily oxidized. This research is review article and it aims to assess the effect of temperature on the antioxidant activity and the decrease of HCN level in *Cassava* leaves. Thermal Process such as heating by oven (dry heating) and cooking (boiling heating) greatly affects the antioxidant activity and the reduction of cyanide acid (HCN) level in *Cassava* leaves. This article may be useful for any one or any researcher to determine the thermal process such as heating temperature and heating method to process prepare *Cassava* leaves.
Keywords: Antioxidant, *Cassava* leaves (*Manihot esculenta* Crantz), HCN level, heating oven.

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INTRODUCTION

Cassava leaves is used as vegetable in some countries, such as in sub-Saharan Africa, and some Asian countries belonging Indonesia, Philippines, and Malaysia. Cassava leaves able to increase breast milk production so it can be consumed by pregnant woman[1]. Beside that Cassave leaves have any effect to against many health proglems, such as rheumatism, fever, headache, diarrhea, loss of appatite, and has been reported that it possess antihemorrhoid, anti-inflammatory, antimicrobial and analgetic activity[2].
Cassava leaves are known to have high nutritional content, including flavonoids and phenolics, which the compounds that act as antioxidants with neutralize free radicals before they cause damage to the body cells. Antioxidant compounds that can inhibit free radicals in the body by giving electrons to free radical molecules so that they make it stable[3].
There are some sources of free radicals in human body, where they can be derived from normal essential metabolic processes in the human body or from external sources, such as exposure to X-rays, ozone, air pollutants, cigarette smoking, industrial chemicals, pesticides and radiation. A free radical is any molecular species that have unpaired electrons in an atomic orbital.

Figure 1: Cassava leaves.

Many radicals are unstable and very reactive. The existence of free radicals can have a negative impact in human body, they attack important molecules such as lipid, nucleic acid, and protein, so it cause to cell damage and homeostatic disruption[4]. The negative effects of free radicals in the body can be overcome with compounds called antioxidant compounds. Antioxidant is a molecule stable able to donate an

electron to free radical and neutralize it, thus it delay or inhibit cellular damage. Antioxidants system in human body cannot work individually without the support of antioxidant intake from food. So if consumption of foods rich in antioxidant component, it able to induce the work cellular antioxidant and suppress excessive cell damage by free radicals[4,5]. Besides Cassava leaves contains valuable nutrients and antioxidant, it also has toxic compound. Cyanide is the toxic compound in Cassava roots and leaves, make it restrict to consumption. There are three different forms of cyanogens in Cassava roots and leaves, these are linamarin, acetonehydrin (lotaustralin) and free HCN. The linamarin and lotaustralin undergo enzymatic reaction produce a toxic free cyanide[6].

In general, people process Cassava leaves as food through by boiling. Boiling is done because it can reduce levels of cyanide acid (HCN) which is toxic. Cyanide acid (HCN) level can be reduced by dry heating (oven) and boiling[7]. Besides that, the thermal process related with degradation of phytochemicals, such as phenolics compound, and it might cause significant loss antioxidant effect[8].

Antioxidant Activity

According to several studies, Cassava leaves contain antinutritional factor such as high fiber content, tannin, polyphenol and phytic acid. Some of these compounds can act as antioxidant and anticarcinogens, depending on the ingested amount. Polyphenol in Cassava leaves are condensed tannin which consists of anthocyanidins. Where there are two have been identified as cyanidin and delphinidin, but mostly it expressed as tannin equivalent. Thermal process such as oven-dried able to reduction of polyphenol content to 48%, while sun-dried and steam process retained at 62% polyphenol[1].

In a study conducted by Kay Zar Lin and Phyu Phyu Myint using samples of Cassava leaves which were dried at room temperature then extracted by percolation method at room temperature using two different solvents, water and ethanol 70%, then the extract was tested for antioxidant activity using the DPPH (1,1-diphenyl-2-picryhydrazyl) method. Then the results of antioxidants in water extract is 42.64 µg/mL and ethanol 70% extracts is 17.69 µg/mL. From the results obtained, ethanol 70% extract has higher antioxidant activity than water extract and both are classified as very strong antioxidants[9].

In a study conducted by Okoro using samples of Cassava leaves, antioxidant activity was tested using the DPPH method. In the treatment, the sample of Cassava leaves was dried at room temperature and extracted by maceration method using 2 different solvents, ethanol 50% and ethanol. Then the evaporation stage is evaporated at a temperature of 40°C. From the results obtained, the ethanol extract has a higher antioxidant activity, which is 29.49 µg/mL, compared to the ethanol 50% extract which is 31.77 µg/mL. The two results obtained are classified as very strong antioxidants[10]. In a study conducted by Malik, *et al*., using a sample of Cassava leaves, the pretreatment was dried in oven with temperature at 60°C, the sample was then extracted by maceration method using ethanol 96%. Then tested its antioxidant activity with the DPPH method, and the yield value of ethanol extract of Cassava leaves is 84.23 µg/mL which is included in the category of strong antioxidant activity[11].

In a study conducted by Faujan, *et al*., using samples of Cassava leaves. It was dryed at 45°C, and then extracted by maceration method with using water and ethanol 70% as solvent. Then tested its antioxidant activity with the DPPH method, and the results of the antioxidant activity of Cassava leaves samples in water extract is 0.085 mg/mL, while the ethanol 70% extract is 0.090 mg/mL, both the antioxidant results are classified as the strong antioxidant category[12].

In research conducted by Hasim, Falah, and Dewi, using a sample of Cassava leaves. Two pretreatment was given, which were drying with an oven at 50°C and boiling at 100°C and extracting each with two solvents and different extraction methods, using maceration extraction with methanol and infundation with water. The antioxidant activity test was carried out using the DPPH method, from this test the results of the antioxidant activity of samples in water extract with boiling and without boiling are 170.77 mg /L and 155.76 mg/L, whereas the methanol extract with boiling and without boiling are 144.28 mg/L and 92.10 mg/L. Then the highest percentage of DPPH radical inhibition is produced by methanol extract without boiling and is classified as a strong antioxidant[7].

Antioxidant activity is strongly influenced by high heating, this is due to the presence of antioxidant compounds, namely phenolics and flavonoids which are easily oxidized when given a high heating temperature, beside that the boiling process of flavonoids and phenolic has decreased because the sample is directly related to the heat produced by boiled water, so that the cell walls and plasma membranes are rapidly damaged. Thus the boiling water enters the cell walls and vacuoles which then dissolve phenol and flavanoid compounds into the water as solvent[13].

Reduction HCN Level

The total of cyanogens present in Cassava roots and Leaves is called cyanogenic potential. Cyanogenic glycosides are effective defense agents against generalist herbivores including humans. Cassava leaves contain cyanide level is range from 53 to 1.300 mg/kg dry weight, it is higher than the WHO recommendation, < 10 mg/kg dry matter. Consumption of 50 to 100 mg of cyanide has been associated with acute poisoning and has been reported to be lethal in adult[(6)]. So to prevent acute toxicity in humans, the cyanide level of Cassava leaves must be appropriate WHO's recommendation. There are many process to remove cyanide level from sample, and one of them is thermal process. In a study conducted by Ojiambo *et al*., using 5 sample varieties of Cassava leaves obtained cyanide acid (HCN) level ranging from 128.24 - 576.30 mg/kg fresh weight. Then the cyanide removal process was carried out at a heating temperature of 95°C by boiling it at 10, 15, 20, and 25 minutes intervals. The results obtained were there are reduction variation of HCN levels in each variety of Cassava leaves, which was found at a time interval of 25 minutes with a highest percentage reduction until

88,65%[14]. In a study conducted by Junior *et al.*, using 3 samples varieties of Cassava leaves, the pretreatment was dry heating and boiling. The initial content of cyanide acid (HCN) levels in Cassava leaf samples were 230, 425, and 561 mg/kg fresh weight. Then the cyanide acid was removed by dry heating at 40°C, 50°C, 60°C, 70°C, and 80°C with time intervals of 30, 60, 120, and 180 minutes, and in the boiling process using temperature 70°C, 80°C, 90°C, and 100°C at time intervals of 30, 60, 120, and 180 minutes. The results obtained showed that drying in oven at 40-80°C and boiling process at 70-100^{o}C are efficient process to removal of HCN level content from cassava leaf. But the boiling process much less efficient than oven drying. The decrease of HCN level content by Oven drying process at 40-80°C was higher than 80% after 180 min of process, thus oven drying at 40°C already effective[15].

The thermal process make laminarase, a heat-labile β-glucosidase, is denatured and laminarin cannot be formed so formation cyanohydrin and free cyanide can be avoided. Beside that cyanohydrin and free cyanide is volatile so can be reduced too by heating[16]. Thus the thermal process hope to reduce its content in Cassava leaves. The difference in the decrease in cyanide acid levels in each variety Cassava leaves are caused by differences in cellular structures that affect the diffusion of substances such as cyanogenic glycosides[14].

CONCLUSION

Based on the results obtained from several studies above, it can be concluded that the pretreatment thermal process is dried at room temperature and at 45^{o}C with the maceration and percolation extraction method, resulting very strong antioxidant activity and strong antioxidant activity. While the lowest antioxidant activity was found in the pretreatment with boiling at 100°C using the infundation extraction method, the results of antioxidant activity were weak in the category of antioxidant. The decrease in cyanide acid level, it can be concluded that the optimum reduction in cyanide acid level is found in dry heating treatment more effective than cooking or boiling process. Where thermal process dry heating at 40^{o}C in 180 minute is already effective to remove cyanide level higher than 80%. Thus it can be concluded that, the pretreatment thermal process by heating greatly affects to the antioxidant activity and the reduction of cyanide acid level in Cassava leaves. So this article want to suggest that pretreatment thermal process with heating by oven or dry heating at 40°C, using the cold extraction method (maceration and percolation).

CONFLICT OF INTEREST

No conflict of interest associated with this work.

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