Indonesian Journal of Chemistry and Environment
Vol. 1, No. 1, December 2017, pp. 7~14
ISSN: 2599-3186

Analysis of Cyanide Content on Yams Using Spectrophotometry Methods

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Article Info

Article history:

Received Oct 11th, 2017
Revised Nov 8th, 2017
Accepted Nov 17th, 2017

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ABSTRACT

This study aims to determine whether or not cyanide content in various species of yams in the District of Tempel, Sleman, Yogyakarta. The samples were cassava (*Manihot esculenta Crantz*), water yam (*Discorea Alata*), intoxicating yam (*Dioscorea hispida Dennst*), canna lilly (*Canna discolor L*), and taro (*Colocasia esculenta*). The qualitative test was performed by cementing the sample with aquadest and 10% tartrate acid and then covering the erlenmeyer that containing the sample with dry filter paper immersed in saturated picric acid and dampened with 8% sodium carbonate and then heating it. Quantitative tests were performed using a spectrum 20 with a wavelength of 590 nm. This quantitative test is based on forming a blue hydrindantin complex at pH > 12 when cyanide is reacted with a ninhydrin complex. The results showed that in qualitative test, sample containing cyanide was indicated by the change of color of filter paper from yellow to brownish red. Quantitative results show that cyanide contained in sample as varies levels. The cyanide levels through the various species of yams were 0.1098 mg / 100g for cassava 0.049 mg/100 g for water yam, 0.1394 mg/100g for intoxing yam, 0.0896 mg/100 g for canna lilly and 0.0680 mg / 100g for taro.

Keywords: *cyanide, spectrophotometry*

1. INTRODUCTION

Districts Tempel, is area located in the northwest, 6 km from capital city district Sleman. Districts Tempel is at an altitude of 320 mdpl and have large region 4,799 Ha. Partially due its territory are in the area plains high fertile, terrain districts Tempel by are overgrown plant. Plant growing various, one of which is tuber crops, among others : sweet potato, cassava or yam wood, taro, intoxicating yam, water yam, canna lilly, anpotatoes. Based on *survey* conducted by researchers, plants tubers are frequent consumed by community local is cassava (*Manihot esculenta Crantz*), intoxicating yam (*Dioscorea hispida Dennst*), water yam *(Diocorea alata)*, canna lilly (*Canna discolor* L), and taro (*Colocasia esculenta*).

Based on data at Indonesian Animal Crops Research Institute and Umbi Malang, tubers have some content nutrition, including protein, fat, carbohydrates, and contain some element as calcium, phosphorus and so on. Because of the content very rich nutrition as well have a lot of benefits, tubers potentially as functional food (Chandrasekara & Kumar, 2016).

In addition to containing the nutrients mentioned above, some tuber plants also contain toxins. Partly big communities in the region districts Tempel, Sleman already knowing that in tubers are almost every day consumed there poison. Type tubers this among cassava (*Manihot esculenta Crantz*), intoxicating yam (*Dioscorea hispida Dennst*), water yam *(Diocorea alata)*, canna lilly (*Canna discolor* L), and taro (*Colocasia esculenta*). However, society not yet knowing type toxins contained in tubers.

Some plant tubers contain compound of glycogen cyanogenic (Poulton, 1990). Ccyanogenic compound is an organic compound containing group cyanide (CN) (Cho, et al., 2013). This compound if hydrolyzed will produce cyanide compound which is very toxic in nature. Cassava contain enzymes that can break glycosides cyanogenic become cyanide (White, Arias-Garzon, McMahon, & Sayre, 1998).

Cyanide compound is a chemistry compound that contains the cyano group (C N). Cyanide is compound which has no colored, very toxic and easy yawn on themperatue 26 ^{o}C. Cyanide can be formed on natural or made by human. Cyanide compound could release the CN^- anion which is very toxic for human (Simeonova & Fishbein, 2004). The compound of cyanide could sign in to body through three ways, which are by breathing, absorbing by skin and digestion (Fukushima, Nicoletti, & Rodrigues, 2016). If cyanide absorbed to human body, it will inhibit taking oxygen cell by blocking enzyme cytochromoxidase, i.e. something a functioning enzyme for transportation oxygen mobile or network (Simeonova & Fishbein, 2004).

Analysis of cyanide could do with spectrophotometry method (Pitschmann, Kobliha, & Tušarová, 2011). A simple instrumentation is spectronic 20, which is only measure absorbance of colored samples. Colored solution inserted to in trailer and could be read absorbance. System optic from tool the could developed as here, the source light form tungsten lamp will radiates rays polychromatic, after past regulator long wave, just rays monochromatic that is passed to solution and rays that pass through solution detected by photodetector.

2. RESEARCH METHOD

The aims of the research were to know the levels cyanide on some types of tubers using the spectrophotometry methods. The samples used in the research were cassava (Manihot esculenta Crantz), water yams (Diocorea Alata), intoxicating yam (*Dioscorea hispida Dennst*), canna lilly (Canna discolor L), and taro (Colocasia esculenta), which were taken directly in Tempel, Sleman, Yogyakarta.

The cyanide content in the tubers is determined using a spectronic 20 instrument. Spectrophotometric methods are used based on cyanide reactions with ninhydrin in alkaline solutions. This method is very sensitive, specific, free from any kind of impurity species and does not require heating. Spectrophotometric is a measurement method with an instrument based on the amount of light absorbed or at a particular wavelength measurement. The measurement is based on the intensity of the color, thus the sample is reacted with ninhydrin at pH =12 and formed a blue solution. The formed color then compared with a standard solution of potassium cyanide.

2.1 Qualitative analysis

Qualitative analysis is done to make sure that sample contain cyanide. Qualitative analysis is based on the cyanide reaction with picric acid in the atmosphere of Na_2CO_3. As much as 20 grams sample were mashed and then macerated with 50 ml of distilled water for 10 minutes. Then into the sample 10 mL of 10% tartrate acid was added. Soak a filter paper with saturated picric acid before dried and re-soaked with 8% Na_2CO_3. The samples in the erlenmeyer were covered with filter paper and then heated in a water bath at 50^{o}C for about 15 minutes. The colour of filter paper will change into red or orange if the samples contain cyanide

2.2 Maximum wavelength determination

The maximum wavelength is determined with a standard solution of potassium cyanide at a concentration of 0.2 ppm. A standard solution of 0.2 ppm concentration was prepared by dissolving 0.2 mL of a potassium cyanide solution of 100 ppm to a volume of 100 mL. Then 1 mL of ninhydrin and 1 mL of Na_2CO_3 were added to the standard solution. The pH is adjusted with 1 M NaOH until it reaches 12. The standard solution is then dissolved to a volume of 10 mL. With spectronic 20, the absorbance was measured at a wavelength of 560-620 nm with a range of 5 nm. The wavelength giving the highest absorbance was used in the absorbance measurement later.

2.3 Determination of absorbance of standard solution

Standard solutions were prepared in 5 different concentrations of 0.1 ppm; 0.2 ppm 0.4 ppm; 0.6 ppm and 0.8 ppm by dissolving potassium cyanide solution with a concentration of 100 ppm. Each solution was then added 1 mL of ninhydrin and 1 mL of Na_2CO_3. Then the pH is adjusted with a solution of NaOH with a concentration of 1 M until the pH reaches 12. The standard solution is then dissolved to 10 mL volume on the measuring flask. All standard solutions were measured with spectronic 20 at a predetermined maximum wavelength of 590 nm.

2.4 Sample preparation

As much as 20 grams sample were mashed with mortar then added with 5 mL of Na_2CO_3 then mixed for 5 minutes. The filtrate of the sample then separated with Buchner filters. Into the filtrate then added 1 ml of ninhydrin. Then the pH is adjusted with a solution of NaOH with a concentration of 1 M until the pH reaches 12. The sample then dissolved with aquadest up to 10 mL on volume measuring flask. The absorbance of sample then be measured with spectronic 20 at maximum wavelength.

3. RESULTS AND ANALYSIS

This research aims to find out whether there is content of cyanide and cyanide levels in knowing some types of tuber i.e. intoxicating yam*(Dioscorea hispida dennst)*, cassava *(Manihot esculenta crantz)*, water yam*(Canna discolor L)*, taro *(Colocasia esculenta)*, and water yam*(Diocorea alata)*. In this research, conducted two types of analysis i.e. analysis of qualitative and quantitative analysis.

3.1 Qualitative Analysis

Qualitative analysis in the research aims to find out whether there is content of cyanide in some samples of the tuber, namely intoxicating yam *(Dioscorea hispida dennst)*, cassava *(Manihot esculenta crantz)*, water yam *(Canna discolor L)*, taro *(Colocasia esculenta)*, and water yam *(Diocorea alata)*, which can be observed from the color change that occurs on a filter paper, namely the yellow color of picrate paper turned into red, orange or brown. This analysis begins by smoothing samples as much as 20 grams so that substances contained therein can be out, so the content of cyanogenic glycosides in tuber yield hydrolyzed CN^-.

Subsequently the smoothed sample, macerated with 50 mL of distilled water for 10 minutes, the maceration process aims to conduct a CN^- dissolution which has been released in the refining process so that the reaction proceeds as follows:

$$CN(g) + H_2O(l) \rightarrow HCN(g) + OH^-(g)$$

After the maceration process, 10% tartrate acid is added which aims to produce HCN vapor. HCN vapor is produced by hydrogen from tatric acid which is related to CN^- and water-soluble ions that produce HCN vapor. As for the reaction that takes place is:

$$2CN^-(g) + 2H^+(g) \rightarrow 2HCN(g)$$

The next step is setting up filter paper diameter ± 10 cm, then the filter paper dipped in picric acid saturated yellow and when it will be hung, at the mouth of an erlenmeyer flask moistened with a solution of Na_2CO_3 8%, this aims so that HCN vapor trapped inside filter paper form compounds Na-picrosianate red-brownish. Filter paper should close the erlenmeyer flask, that meeting of filter paper is not experiencing contact with the liquid in an erlenmeyer flask. Afterwards heating the erlenmeyer that has been sealed with filter paper above 50^{o}C water bath for 15 minutes.This heating process serves to accelerate the reaction of HCN with picric acid and Na_2CO_3. After that, observe the color change that occurs on a filter paper, namely the yellow color of picrate paper turned into red, orange or brown to find out there is whether or not the content of cyanide in the sample. The equation of the reaction that occurs in its entirety in the qualitative analysis is as follows:

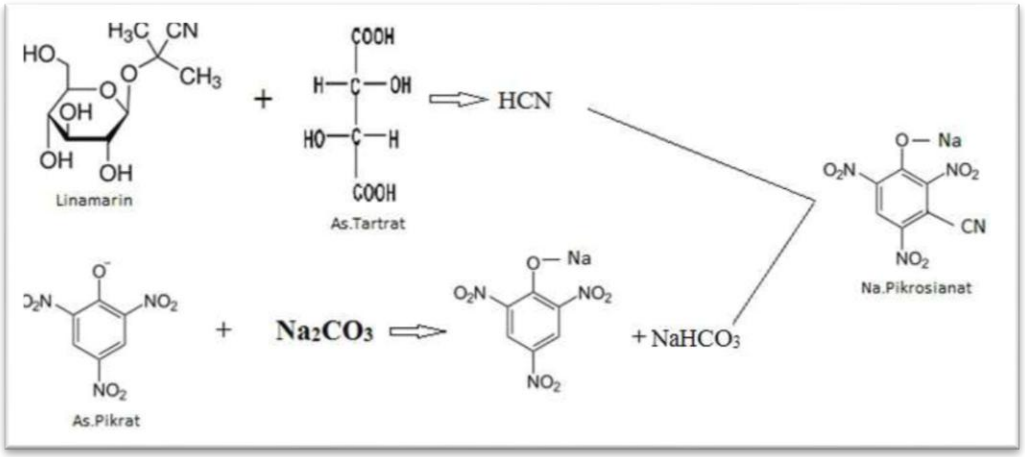

Figure 1. The chemical reaction in qualitative analysis of cynide on yams

From the observations that have been made, the obtained qualitative test results of samples visually intoxicating yam, water yam, cassava, taro, and the water yam was positive and showed a cyanide content due to the color change to yellow from the filter paper changed to orange color. As for the qualitative analysis results can be seen in Table 4 below:

Table 1. Qualitative analysis of cyanide on yams

No.	Types of Tuber	Discoloration (on filter paper)		Cyanide Content
		Before	After	
1.	Intoxicating yam	Yellow	Orange-Brownish	+
2.	Cassava	Yellow	Orange-Brownish	+
3.	Water yam	Yellow	Orange	+
4.	Taro	Yellow	Orange	+
5.	Water yam	Yellow	Orange	+

3.2 Quantitative Analysis

The purpose of quantitative analysis this research was to know the cyanide content from tuber samples use spectronic 20. This analysis is based making hydrantin complex structure which is formed from the reaction between cyanide and nynhidrin. Such complex compound detected by spectronic 20.

Addition of nynhidrin aims to form complex compound that are red and blue in a high base state (pH 12-14). In that state cyanide forming ion CN^- , while addition of Na_2CO_3 aims to form a stable cyanide compound and not volatile. Reactions that occur following

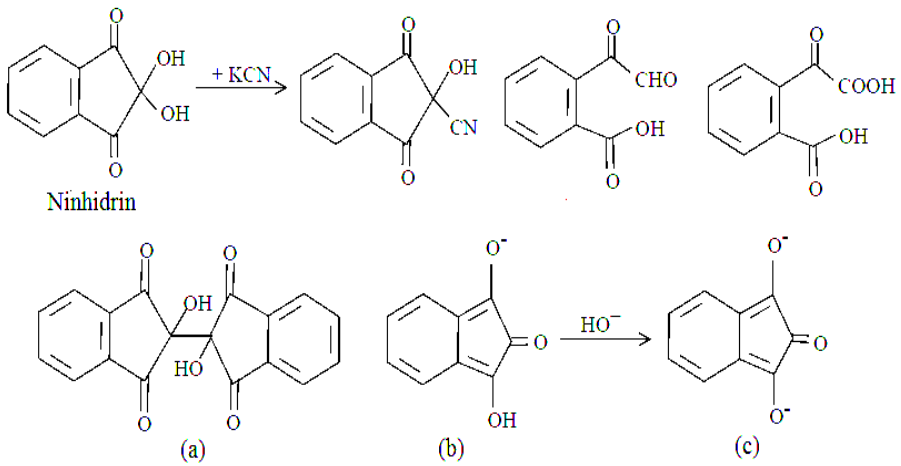

Figure 2. Chemical reaction between nynhidrin and CN^-

Standars solution of 2 ppm is used to determine maximum wavelength. The maximum wavelength is wavelength that yields the greatest absorbance value. The measured wavelength ranges from 560 to 620 nm with scale five. The wavelength relation curve with absorbance is presented below.

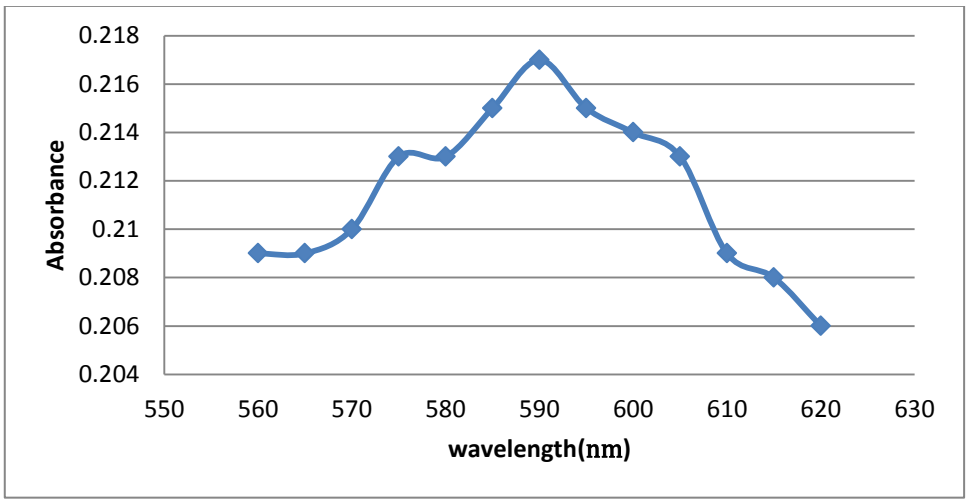

Figure 3. Determination of maximum wavelength of cynide using spectronic 20

Based on the graph, the maximum wavelength is 590 nm. This maximum wavelength was used to determine theabsorbanceod standard solutions.

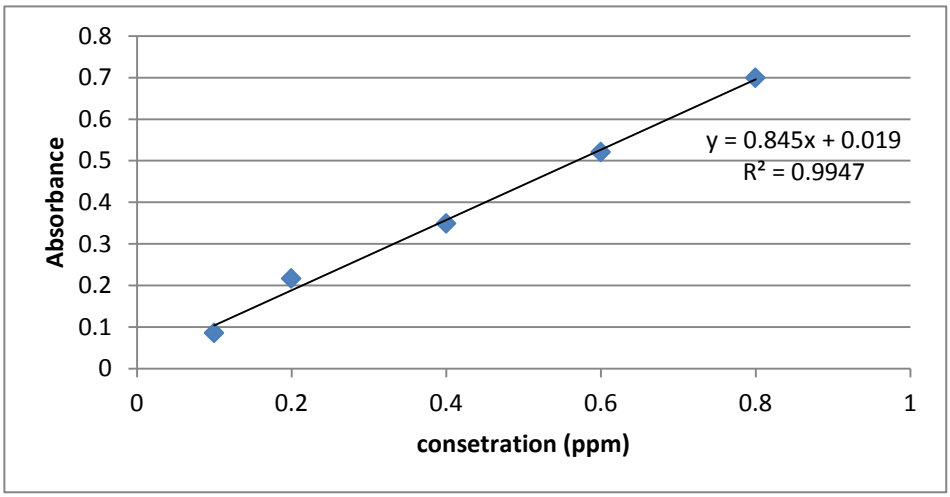

Figure 3. The standard curve of cyanide solutions.

Based the graph, the regretion value was obtained, which was y = 0.845x + 0.0195. Using this equation, the concentration of cyanide in each sample solution was detemined.

Table 2. The concentration of cyanide in each sample solutions

No.	Tuber types	Absorbance	Concentration (ppm)
1.	Intoxicating yam	0,608	0,697
2.	Cassava	0,483	0,549
3.	Water yam	0,397	0,448
4.	Taro	0,307	0,340
5.	Water yam	0,226	0,245

By applying the formula:

$$K = \frac{V.C}{W}$$

K = cyanide levels (mg/g)
V = sample solution volume (mL)
C = cyanide concentration in the sample solution (ppm atau mg/mL)
W = weight of sample solution (gram)

The following cyanide content was obtained.

Table 3. The levels of cyanide in various yams

No.	Tuber types	levels (mg/100 g)
1.	Intoxicating yam	0.1394
2.	Cassava	0.1098
3.	Water yam	0.049
4.	Taro	0.0680
5.	Canna lilly	0.0896

The cyanide content allowed by the community to be consumed is 4 mg / 100g. Based on this research, tuber samples have relatively little cyanide content that is less than 4 mg / 100g so that tuber is safe for consumption by society.

4. CONCLUSION

Based on the analysis of the results of research conducted, it can be concluded as follows:

a. All of the various species of yams in Tempel,Sleman, Yogyakarta consists of cyanide, both in qualitative as well as quantitative analysis.
b. The cyanide levels through the various species of yams were 0.1098 mg / 100g for cassava, 0.049 mg/100 g for water yam, 0.1394 mg/100g for intoxing yam, 0.0896 mg/100 g for canna lilly and 0.0680 mg / 100g for taro.

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