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The concentration of NaCl soaking to decreasing cyanide levels in Gadung (Dioscorea hispida Dennst)

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HIGHLIGHTS

Soaking 5% NaCl in G*adung* tubers containing cyanide can reduce cyanide levels by 99.70%

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Cyanide is one component contained in *gadung* tubers, and therefore, consuming gadung that contains more than 1 ppm of cyanide can cause nausea and intoxication. This research aims to study the effect of concentration variation of NaCl soaking to the decrease of cyanide levels in *gadung*. This research is an experimental study with three treatment. Testing is only done once. Samples of *gadung* were soaked by NaCl (0% 1% 3% 5%) for 3 days. Determination of cyanide content in *gadung* used the UV-Vis spectrophotometry method by adding Ninhydrin 0.1% in Na_2CO_3 2% and NaOH 0.1 % in the sample filtrate. Result of this research had shown that cyanide content in *gadung* before NaCl soaking was 4.42 ppm and after NaCl soaking (0% 1% 3% 5%) were 3.52; 2.53; 0.43 and 0.01 ppm, respectively.

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1. INTRODUCTION

Gadung plants are easy to grow in critical land without special care.[1] *Gadung* plants grow wild in dry forestlands and can be cultivated in a home garden. This plant grows at an altitude of 850 - 1,200 meters above sea level.[2] Yogyakarta people process *gadung* tubers into chips.[3] In Nusa Tenggara and Maluku, *gadung* tubers are consumed to substitute sago and corn during the dry season.[2] Gadung is also found in other countries, and the people commonly use it for traditional medicine due to its efficacy in medication for illnesses, such as leprosy, dermatitis, abdominal spasms, as well as in the making process of oral contraception.[4]

Gadung tuber contains cyanide (CN^-), which has a negative effect on health.[5] Results of the study have uncovered that fresh *gadung* tubers contain cyanide levels of 469.5 ppm.[6] Consuming *gadung* tuber with a very high level of cyanide potentially causes

nausea, motion sickness, even death.[5] Based on SNI (Indonesian National Standard), the maximum limit of cyanide levels in food products is 1 ppm.[7] The cyanide content (CN^-) in *gadung* tubers needs to be minimised and eliminated by several processes so that the *gadung* tubers are safe and suitable for consumption.

Some alternative processing methods commonly carried out by the community are soaking tubers in water and smearing them with ash. However, the immersion method takes about 3-5 days and needs to be done so that it is considered less efficient.[6] The process smearing with ash is inefficient because it requires many stages of treatments and takes up to 10 days. Another method is soaking *gadung* tubers into a salt solution.[8] The use of salt solutions in soaking *gadung* tubers can cause differences in osmosis pressure inside and outside the material so that the osmosis diffusion process occurs from the inside part into the outside part of the dissolved material.[8] When the concentration of the salt solution is too high, the osmosis process between water and solute (cyanide) gets faster.

Previous studies on *gadung* immersion used table salt and calcium solutions. The use of NaCl solution with various levels of concentration in the immersion in this research has never been applied in the previous research. The purposes of this study were to determine cyanide levels in *gadung* tuber samples before and after NaCl immersion and to determine the optimum concentration of NaCl which can reduce cyanide levels (CN^-) in *gadung* tuber samples.

2. MATERIALS AND METHOD

This research is an experimental study with three treatment. Testing is only done once.

2.1. Tools and materials

The tools used for determining cyanide levels in the sample: UV-vis spectrophotometric. Reagent materials needed: distilled water, NaCl (1%, 3%, 5%), CN p 10 ppm, 0.1 M NaOH, 0.1% Ninhydrin, and 2% Na_2CO_3. The research material was *gadung* tuber obtained from Magetan Regency.

2.2. Procedure

2.2.1. Sample Preparation

Gadung tubers were cut 3 mm thick, pounded using mortar. The sample was then weighed five grams and added 10 ml of distilled water. Next, it was filtered using Whatman filter paper no.42 until a clear filtrate was obtained. The filtrate was later tested qualitatively and quantitatively.

2.2.2. Qualitative Analysis

Qualitative analysis of cyanide was done by pipetting 2 ml of *gadung* tuber filtrate to the test tube and adding 1 ml of 0.1% ninhydrin solution in 2% Na_2CO_3. Then, 15 drops of 0.1 M NaOH were added and homogenized. Finally, the colour changes occurred.[9]

2.2.3. Determination of Maximum Wavelength

Solution (CN^-) of 1 ppm was pipetted as much as 2 ml and put in the test tube. 1 ml of 0.1% ninhydrin solution was added in 2% Na_2CO_3. Then, 15 drops of 0.1 M NaOH were added and homogenized. After the materials reacted, the colour changes occurred. The maximum wavelength was read using a UV-Vis spectrophotometer in the range 400 - 620 nm.[9]

2.2.4. Determination of Sample Level

Gadung tuber samples were cut with 3 mm thickness. The cuts were later soaked in NaCl solution (with concentration of 0%, 1%, 3%, and 5%) for three days. A total of 5 grams of refined *gadung* tuber samples were soaked in 10 mL of distilled water. Then, it

was filtered using Whatman filter paper no.42 until a clear filtrate was obtained. Next, 2 ml of the filtrate is pipetted and put into the test tube. 1 ml of 0.1% ninhydrin solution was added into 2% Na_2CO_3. Finally, 15 drops of 0.1 M NaOH were added and homogenized. Finally, the colour changes occurred.[9]

3. RESULTS AND DISCUSSION

The results of the qualitative test on *gadung* tuber samples before immersion can be seen in Figure 1. The findings show that an identical purple/blue colour was formed both in the sample and in positive cyanide control.

A B C

Figure 1. Qualitative Cyanide Test (CN^-)

Description:
A = *gadung* tuber sample before immersion
B = positive control (containing cyanide)
C = negative control (not containing cyanide)

Qualitative tests carried out by reacting the *gadung* tuber extract with 0.1% ninhydrin reagent in 2% Na_2CO_3, and 0.1 M NaOH demonstrate that the sample of *gadung* tuber was identified containing cyanide (CN^-). The reaction between cyanide in *gadung* tuber with ninhydrin and NaOH resulted in purple/blue discolouration. The formation of purple/blue colour is obtained, exposing that ninhydrin forms red colour if reacted with cyanide. When NaOH is added, it forms a purple/blue colour.

Determination of the absorption value of a sample must be at the maximum wavelength so that the maximum value is obtained. The results of determination of the maximum wavelength using a UV-Vis spectrophotometer in the wavelength of 498 nm. The determination of the calibration curve was obtained from the concentration of 10 ppm of cyanide stock solution (CN^-). The solution was then diluted to five concentrations, namely 1 ppm, 2 ppm, 3 ppm, 4 ppm, and 5 ppm. The absorbance levels of the five concentrations of standard solutions were measured at a wavelength of 498 nm. From the calibration curve, a regression equation $y = 0.1273X + 0.022$ was obtained.

The determination of initial levels of cyanide in *gadung* tuber samples before treatment was carried out three times. The absorbance obtained were: 0.572; 0.596, and 0.586. The average absorbance value was: 0.5847. The value of cyanide concentration in *gadung* tubers before treatment was: 4.42 ppm. Cyanide content in *gadung* tuber samples was still above the SNI standard value with a maximum cyanide content of 1 ppm.[7]

The results of immersion of *gadung* tubers with 0%, 1%, 3% and 5% NaCl are demonstrated in Table 1. *Gadung* tuber samples were soaked for three days in NaCl solution (0%, 1%, 3%, and 5%), and purple/blue colour that was less bright than the colour before immersion treatment was obtained. This research shows that the cyanide level in the sample after treatment decreased. The absorbance value of the sample proves it before treatment, which was higher than that after immersion.

Table 1. Determination of Cyanide Levels after Immersion with NaCl Concentration

Variation of Concentration (%)	Average Cyanide Level (ppm)	Decrease Percentage (%)
NaCl 0	3.52	20.26
NaCl 1	2.53	42.77
NaCl 3	0.43	90.28
NaCl 5	0.01	99.70

Based on research carried out, *gadung* tubers immersion using 3% and 5% NaCl can reduce cyanide levels up to 90.28% and 99.70%, with cyanide levels of 0.43 ppm and 0.01 ppm. Therefore, it can be implied that the immersion of 3% and 5% NaCl can reduce cyanide levels in *gadung* tubers to the safe limit of cyanide content in food products SNI (Indonesian National Standard) year 2015 which stipulates that the maximum limit of HCN level is 1 ppm.[7] Some previous studies have revealed that the immersion result of *gadung* tuber using table salt 5% for three days is 66.99%.[9] To compare two variables of the immersion with the same concentration (5%), NaCl is considered more effective because it can reduce the cyanide level-up to 99.70%.

The decrease of cyanide level is due to the osmosis diffusion process when the immersion of *gadung* tuber using salt solution is carried out.[10,11] The cyanide (HCN) compounds formed in *gadung* tuber undergo the osmosis diffusion and then bind to Na^+ on NaCl to form NaCN. According to the research in which *gadung* is immersed using $Ca(OH)_2$, it is found that Ca^{2+} can bind to HCN to produce $Ca(CN)_2$, which is easily dissolved in water.[12] The difference in the immersion between NaCl solution and table salt solution is because table salt solution is composed of several types of salt. The most prominent component of the table salt is NaCl compound, but there are other compositions such as $CaSO_4$, $MgSO_4$, $MgCl_2$, KCl, NaBr, and iodine.[13] These new salt compounds cause the osmosis diffusion process in table salt immersion less efficient compared to that using NaCl, which does not contain any other disturbing compounds. One of the factors that affect the osmosis reaction is that the molecules which are smaller than the centre line of the membrane hole will be more easily absorbed. Some salt compounds can be hygroscopic, that they absorb water from the tissue and damage cell walls and cause plasmolysis (cell membrane rupture due to lack of water).[14]

The practical application developed in this research is the use of table salt, especially NaCl, which can serve as the alternative method to reduce the cyanide level in *gadung* tuber before the technological processing is carried out. Further studies regarding the importance of organoleptic of *gadung* tuber can be improved. The parameter of organoleptic aims to determine the colour, scent, and taste of *gadung* tuber after the immersion using NaCl, for instance, by steaming, boiling, and frying. The processing of *gadung* tuber by frying can also reduce the cyanide level because the cyanide that is dissolved in water will evaporate with water particles during the frying process.[15] The processing method by drying the tuber starch can also reduce some toxics.[15,16] Several parameters that can be applied in further research are starch, water, ash, fibre, and nutrient in *gadung* tuber after treatment.

4. CONCLUSION

The results of the qualitative test show that *gadung* tubers contain cyanide. Quantitatively, the cyanide levels in *gadung* tubers before immersion treatment were 4.42 ppm. The optimum decrease in cyanide levels correlates with the immersion of 5% NaCl by the percentage of 99.70%.

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