L) after the Eruption of Mount Sinabung using Atomic Absorption Spectrophotometer

Analysis of Arsenic in Purple Cabbage (*Brassica Oleracea var. capitata* L) after the Eruption of Mount Sinabung using Atomic Absorption Spectrophotometer

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Abstract: The negative impact after the eruption of Mount Sinabung is the exposure of heavy metals to plants and animals around the mountain. The heavy metal commonly contained in vegetables is Arsenic. Many of the people around Mount Sinabung work as cabbage farmers. Cabbage plants that have many benefits, especially in medicine are purple cabbage (*Brassica oleracea var. Capitata L*). This work aims to analyze the levels of arsenic contained in purple cabbage after the eruption of Mount Sinabung. The sampling technique uses simple random sampling. Sampling was carried out at 5 points of collection which is 50 m from Mount Sinabung. In this work, Dry destruction method was developed using HCl and nitric acid. Instrument Atomic Absorption Spectrophotometers (AAS) equipped with Vapor Hydride Generation Acessories were developed to analyze Arsenic levels. At a wavelength of 193.7 nm, The concentration of arsenic in purple cabbage was obtained at the sampling points 1, 2, 3, 4, and 5 respectively: 0.4755, 0.5808, 0.6534, 0.5517, 0, 5481 mg / Kg. This result is lower than the maximum limit of arsenic contamination in vegetables, which is 1.0 mg / Kg. (SNI No. 7387: 2009).

1 INTRODUCTION

Mount Sinabung is located on the Karo Plateau in Karo Regency, North Sumatra. The mount Sinabung and Mount Sibayak are two active volcanoes in North Sumatra (Lee, Lu, and Kim 2017). Mount Sinabung is 2,460 meters above sea level. The mountain began to erupt again on August 29, 2010. In early 2019, Mount Sinabung began to erupt and emitted hot lava. (Kusmartini et al. 2017).

In this case, the various activities of Mount Sinabung have both positive and negative impacts on local residents who will immediately feel the negative impact, for example when Mount Sinabung erupts, Mount Sinabong emits hot clouds and lava that carry a lot of energy when it flows. Faded white volcanic dust covers the surrounding forests, villages and agricultural land (Nain Felix Sinuhaji 2011), so it is necessary to conduct studies on the dangers of volcanic ash for local residents, plant health, the condition of local livestock, and the dangers posed to crops and livestock (Lee, Lu, and Kim 2017). The volcanic dust after the eruption of Mount Sinabung produces heavy metals such as arsenic and various other heavy metals which have an impact on the quality of agricultural products including cabbage (Harahap 2019)

Arsenic is the most toxic chemical and metalloid in nature, and is also an important element that needs attention, because even at low concentrations, arsenic can cause toxicity and carcinogenicity (Golui et al. 2017). Arsenic exposure to humans can be inorganic or organic. Arsenic in the environment can be in the form of natural substances or pollution caused by human activities (Šlejkovec et al. 2021). Arsenic can be found in water, air, food and soil, including volcanic eruptions, mining pollution, and use of pesticides and fertilizers (Hazimah and Triwuri 2018). The toxic effects of arsenic are well known, but depend on the organic or inorganic form of the arsenic compound (Harahap 2019).

Inorganic arsenic compounds are more toxic than organic compounds (Hazimah and Triwuri 2018). Arsenic is a carcinogen because long-term exposure increases the risk of many types of cancer,

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including skin cancer, bladder cancer, lung cancer, kidney cancer, liver cancer, and prostate cancer (Rokayya et al. 2013). The effects of arsenic are related to changes in the gastrointestinal tract, cardiovascular system, blood, lungs, nerves, immunity, reproduction and long-term effects caused by arsenic (Fikri, Setiani, and Nurjazuli 2012). According to a study by the International Agency for Research on Cancer (IARC), arsenic is listed as a category first carcinogen, suggesting that arsenic can cause human lung cancer, skin cancer and bladder cancer. There is no minimum threshold, and small amounts of arsenic can be harmful to the human body for human health (Singh, Kumar, and Sahu 2007).

Ginting, E.E. (2018) was reported about arsenic (As) in rice. Rice circulating in the community still contains arsenic. The highest arsenic content is found in rice circulating in Medan of 3.40 mg / kg (brown rice), 0.33 mg / kg (white rice), and 0.13 mg / kg (black rice) (Ginting, Silalahi, and Putra 2018). Ridwan, M.H. (2017) was studied about arsenic (As) in spinach using AAS. The results showed that arsenic levels = 0.35 mg / kg (green spinach) and 0.40 mg / kg (red spinach) (Harahap 2019). The compound arsenic (As) was believed to have been exposed to farmers' cabbage, which was exposed by the eruption of Mount Sinabung. Analysis of Arsenic Metal using AAS has also been studied in University of Syiah Kuala Banda Aceh (Nasir, Sulastri, and Hilda 2018). In this study, a dry digestion method was developed on soil samples. The AAS used is a hydride vapor generator. On garden soil, arsenic was detected at 1.6860 ppm. In this work, purple cabbage leaves were analyzed using atomic absorption spectrophotometry (AAS) by taking samples at 5 points.

2 METHOD

2.1 Material

The materials used include purple cabbage from the post-eruption area of Sinabung Mount. Nitric acid 65% (Sigma Aldrich), Standard of Arsenic (Germany), hydrochloric acid 37% (Merck), and sodium hydroxide 97% (Sigma Aldrich).

2.2 Collecting Samples

The vegetables used as samples were purple cabbage *(Brassica oleracea var. Capitata L)* which was in the area after the eruption of Mount Sinabung. Simple random sampling technique was applied in this work. In this method, sample members are selected directly from the entire population by not dividing the population according to groups because they are considered to have the same chance of being selected. So in this way the population was considered as one large group, where the sample was taken to represent the population.

2.3 Destruction Process

Each sample taken from 5 points was weighed 50 g and then dried in an oven at 100°C for 3 hours. The samples were then placed in an oven at 400°C for 4 hours. Once in cold conditions, the sample was dissolved with a mixture of 65% HNO_3 and 37% HCl in a ratio of 5: 2. The next process is to heat it on a hot plate until the sample dissolves. The sample solution was transferred to a 100 ml volumetric flask, then add demineralized water to the mark. The resulting solution was analyzed using an atomic absorption spectrophotometer (AAS) and equipped with Vapor Hydride Generation Accessories.at a wavelength of 193.7 nm.

2.4 Calibration Curves

Arsenic standard solution with a concentration of 1000 µg / ml was used as much as 10 mL and put in a bottle 100 mL and sufficient with demineralized water; up to the mark. In this process Arsenic is produced with a concentration of 100 ppm. 5 mL of the solution is pipetteed and put into a 500 mL volumetric flask and then sufficient to mark the line with aquademineral (concentration 1 µg / ml). The solution with a concentration of 1 µg / ml was then diluted into a standard solution with variations of 0.0 0.2 0.4 0.6 and 0.8 µg / ml.

2.5 Arsenic Analysis

The absorbance was measured using an atomic absorption spectrophotometer at a wavelength of 193.7 nm. The absorbance and concentration values will be plotted to obtain a calibration curve then the regression equation is calculated, namely $y = ax + b$.

3 RESULT

3.1 Destruction Process

Determination of Arsenic (As) in Purple Cabbage *(Brassica oleracea var. Capitata L)* taken from

Berastagi Sub district, Dry destruction was developed in the furnace at 400° for 3 hours until white ash was formed, then dissolved using HNO_3 and washed used demineralized water, the filtering process was carried out with Whatmann filter paper No 42.

In this work, HNO_3 functions to break down the sample into compounds that are easier to decompose while demineralized water was used to wash the sample solution left on the filter paper. The dry destruction method was used to break the bonds between the organic compounds and the metal being analyzed. Nitric acid was an oxidizing agent which can decompose the sample into its elements.

3.2 Analysis of Arsenic Used AAS

The calibration curve of the arsenic (As) standard solution was carried out by preparing a standard series solution with various concentrations at 0.0 0.2 0.4 0.6 and 0.8 µg / ml. The absorbance value was obtained using Atomic Absorption Spectrophotometry (AAS). The conditions of the Atomic Absorption Spectrophotometry (AAS) instrument on the measurement of Arsenic concentration can be seen in **Table 3.1** and The absorbance data of the Arsenic standard curve can be seen in **Figure 3.1** below.

Table 3.1: The conditions of the Atomic Absorption Spectrophotometry (AAS) instrument.

No	Parameter	**Condition**
1	Wavelength (nm)	193,7
2	Flash type	air- C_2H_2
3	Burner Gas Flow Rate	2,0
4	height	7,5
5	Type of Lamp	BGC-02
6	Gap Width (nm)	1,3

Table 3.1. shows that the As analysis uses the AAS nm instrument with a hydride vapor generator at a wavelength of 193.7 nm. The flash type is air-C_2H_2, Burner Gas Flow Rate at 2.0, height = 7.5, type of lamp BGC-02 and Gap Width (nm) = 1.3. This condition was chosen because it is the optimum condition for measuring or Arsen in a vegetable sample.

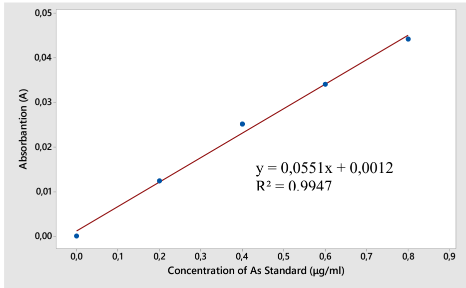

Figure 3.1: Arsenic standard curve.

Figure 3.1. shows the standard serial curve used on AAS Instruments. The straight-line equation obtained is y = 0.0551x + 0.0012. The resulting correlation coefficient is 0.9947. Based on this data, it can be seen that there is a positive correlation between the concentration of the standard series sample and the resulting absorbance value. Based on the results of the calculations made, the levels of Arsenic in purple Cabbage (*Brassica oleracea var. Capitata L*) were obtained for points 1, 2, 3, 4, and 5 respectively as shown in **Figure 3.2.** the following :

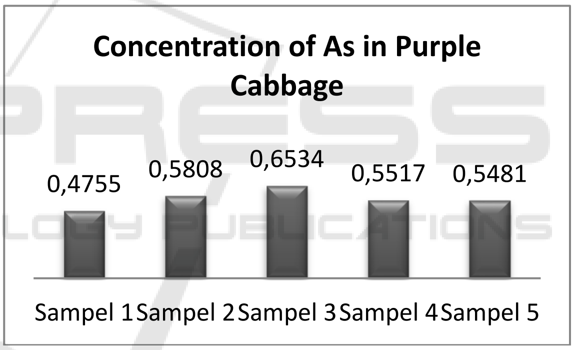

Figure 3.2: The concentration of Arsenic in Purple Cabbage (*Brassica oleracea var. Capitata L*).

Figure 3.2. showed that the levels of Arsenic obtained in purple cabbage (*Brassica oleracea var. Capitata L*) taken at 5 sample points were 0.4755, 0.5808, 0.6534, 0.5517, and 0.5481 mg / Kg respectively. The results obtained are still below the threshold, where the maximum value of Arsenic in vegetables is 1 mg / Kg SNI No. 7387: 2009.

Arsenic is a heavy metal and can cause poisoning if it accumulates in the human body. Heavy metals have been detected in many vegetables. Especially plants grown near highways and air pollution areas, including plants from factory fumes and motor vehicle fumes (Šlejkovec et al. 2021). Arsenic accumulates mainly through plant organs (such as leaves, stems, roots, and tubers), and accents can also accumulate through food contaminated with heavy metals. If this situation continues for a long time, it can reach levels that are harmful to human health. Arsenic in the body can damage health in various ways, namely reducing the number of red blood cells, decreasing hemoglobin synthesis which causes anemia. Anemia occurs due to the binding of arsenic with enzymes (Fikri, Setiani, and Nurjazuli 2012). This results in inhibition of red blood synthesis.

The mechanism of entry of Arsenic into the human body can be through the oral respiratory system, or directly through the skin surface. As much as 95% of the arsenic is absorbed in the body, it is bound by erythrocytes and then removed by the blood to the body organs and then stored in soft tissues (bone marrow, nervous system, kidneys, liver) and hard tissues (bones, nails, hair, teeth) (Nasir, Sulastri, and Hilda 2018) (Fikri, Setiani, and Nurjazuli 2012).

4 CONCLUSION

This research has analyzed the Arsenic metal in the purple cabbage (*Brassica oleracea var. Capitata L*) after the eruption of Mount Sinabung. The sampling technique uses simple random sampling at 5 points of collection which is 50 m from Mount Sinabung. Dry destruction method was developed using Atomic Absorption Spectrophotometers (AAS) equipped with Vapor Hydride Generation Acessories at 193.7 nm. The concentration of arsenic in purple cabbage was obtained at the sampling points 1, 2, 3, 4, and 5 respectively: 0.4755, 0.5808, 0.6534, 0.5517, 0, 5481 mg / Kg. This result is lower than the maximum limit of arsenic contamination in vegetables, which is 1.0 mg / Kg. (SNI No. 7387: 2009)

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