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Analysis of Copper and Lead in Nata de Coco

Annida Fadlila Hanan[1], Jahra Najdah Alfiah[2], Safira Rizqi Annisa[3], Hindun[4]
[1,2,3,4]Department of Chemistry Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

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Corresponding Author:

Annida Fadlila Hanan
Dep. of Chemistry Education
Universitas Negeri Yogyakarta

Email:
annidafadlila.2020@student.uny.ac.id

ABSTRACT

The content of heavy metals in nata de coco has become a polemic in Indonesia due to the use of fertilizers such as urea, NPK, and ZA as a source of nitrogen and it is feared that it will leave residues in nata de coco products. The purpose of this study was to analyze the levels of heavy metals Cu, copper, and Pb, lead, in branded and bulk nata de coco. Samples were analyzed using AAS. The results of the analysis showed that the Cu content in branded and bulk nata de coco was the same, which is 0.00096 mg/g. The Pb content in branded nata de coco was not detected, but in bulk nata de coco it was found to be 0.0409 mg/g. Pb content far exceeds the threshold of SNI 01-4317-1996.

Keyword: nata de coco, copper, lead

1. INTRODUCTION

Fiber is a food component derived from plants and resistant to human digestive enzymes. Fiber plays a preventive role against degenerative diseases (Rohmalia & Kusuhargina, 2021). However, the adequacy of fiber in Indonesia's population is still lacking, as much as 95.5% of Indonesia's population does not consume enough fruits and vegetables (Riskesdas Team, 2019). Lack of fiber can be overcome with fruit and vegetable substitutes as a provider of fiber. The development of food processing technology supports the diversity of food products. One of the products of food processing technology that can overcome the shortage of fiber in Indonesia is nata.

Nata is an extracellular polysaccharide produced through the fermentation of coconut water by the bacterium Acetobacter xylinum (Sari & Nurmiati, 2014). Acetobacter xylinum bacteria require a source of nutrients Carbon (C), Hydrogen (H), Nitrogen (N), and minerals in the production of nata (Hamad & Kristiono, 2013). However, the content of nitrogen and carbon in coconut water is insufficient to support the development of Acetobacter xylinum bacteria. Therefore, additional nitrogen sources are needed in the nata de coco manufacturing process in the form of urea, NPK, and ZA fertilizers, while additional carbon sources come from sucrose, glucose, fructose, and flour (Iguchi et al., 2020). However, the use of fertilizer as a source of nitrogen has become a polemic in Indonesia because it is feared it will leave residue in the nata de coco. Alloway (1995) states that Cu and Pb are contained in ZA fertilizers. Meanwhile, Santosa & Wirawan (2019) also stated that Cu is present in NPK fertilizer as a micronutrient.

A previous study conducted by Kholifah (2010) stated that there were heavy metal contamination of Cu and Pb that exceeded the threshold in nata de coco samples from the market. The contamination comes from ZA fertilizer and the tools used during the fermentation process. Meanwhile, Santosa and Wirawan (2019) studied the characteristics and content of heavy metals in nata de coco which used NPK fertilizer as a nitrogen source. The addition of NPK turned out to leave heavy metal Cu residue. Another study conducted by Asri and Wisanti (2017) concerning the effect of incubation time and administration of tenderizers on the quality of nata de coco stated that there was a heavy metal Pb content on the 6th day of incubation, which was 0.216 mg/L. Nevertheless, the content of heavy metal Pb is still below the SNI threshold

Analysis of Cu and Pb heavy metal content can use Atomic Absorption Spectroscopy (AAS) (Agustina, et al, 2019; Safitri & Kristianingrum, 2020). AAS is widely used to identify heavy metals because it has high selectivity and sensitivity (Gandjar & Rohman, 2007). AAS is appropriate for analyzing samples at low concentrations (Khopkar, 1990). Many studies have been carried out on the content of heavy metals Cu and Pb. However, studies that compare the content of heavy metals Cu and Pb in branded and bulk nata de coco products are still minimal. Therefore, this research will focus on the analysis of the content of heavy metals Cu and Pb in packaged and bulk nata de coco.

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2. RESEARCH METHOD

2.1 Tools and Materials

The tools used in this research is atomic absorption spectrophotometer (AAS) Shimadzu AA-7000, hotplate, analytical balance, glass beaker 100 mL, mortar, pestle, oven, muffle furnace, 10 mL volumetric flask, 100 mL volumetric flask, flask measuring 1000 mL, watch glass, glass stirrer, volume pipette, ball pipette, porcelain crucible, crucible pliers, sample vials, spray bottles and test tubes. The materials needed in this study were branded and bulk nata de coco, concentrated HNO_3, $CuSO_4.5H_2O$, $Pb(NO_3)_2$, distilled water, aluminum foil, and filter paper.

2.3 Sample Preparation

Sample preparation was carried out by dry destruction method. The first step is to slice the nata de coco measuring approximately 0.5 cm x 0.5 cm x 0.5 cm and then dry it in the sun for 2 days. After that, the samples were baked for 5 hours at 250°C. The dried nata de coco samples were then ashed in a muffle furnace for 4 hours at 300°C (Asrillah et al., 2017). Furthermore, as much as 1 gram of ash was dissolved using a concentrated HNO3 solution by heating. The solution obtained was then diluted as much as 100x and filtered using filter paper and then put into a test tube

2.3 Preparation of 1000 ppm Cu Stock Solution

A 1000 ppm Cu stock solution was prepared by adding 0.393 grams of solid $CuSO_4.5H_2O$ to a 1000 mL volumetric flask, then adding distilled water up to the etching mark. After that, the volumetric flask was closed and then shaken until the solution in it was mixed evenly.

2.4 Preparation of 1000 ppm Pb Stock Solution

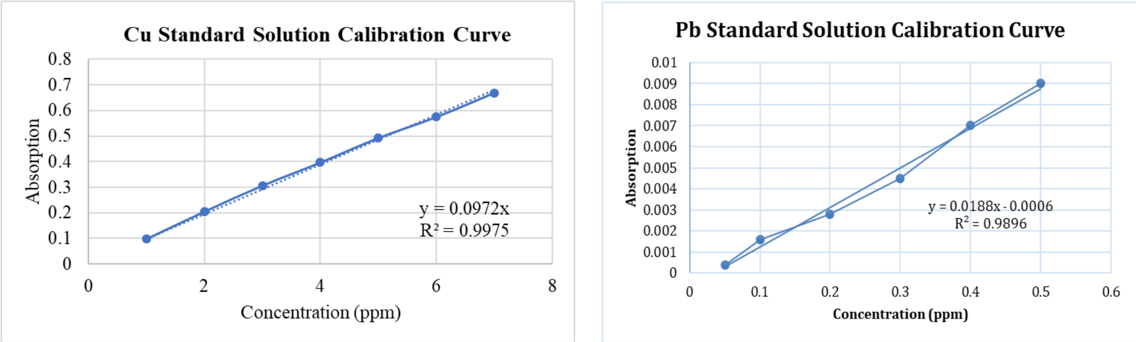
A 1000 ppm Pb stock solution was prepared by adding 1,598 grams of solid $Pb(NO_3)_2$ to a 1000 mL volumetric flask then adding distilled water up to the etching mark. After that, the volumetric flask was closed and then shaken until the solution was mixed.

2.5 Preparation of Cu Standard Solution

The 1000 ppm Cu stock liquid was first diluted to 100 ppm by taking 5 mL of 1000 ppm Cu stock liquid and then putting it into a 50 mL volumetric flask. After that, distilled water was added until the etching marks were shaken. After that, a solution is made standard Cu with concentrations of 1 ppm, 2 ppm, 3 ppm, 4 ppm, 5 ppm, 6 ppm, and 7 ppm. The absorbance of Cu in the nata de coco sample was measured at the maximum wavelength, which is is 324.8 nm (Asrillah et al., 2017). The regression equation used in calculating Cu heavy metal can be seen in Figure 1(a).

2.6 Preparation of Pb Standard Solution

The 1000 ppm Pb stock liquid was first diluted to 10 ppm by taking 1 mL of 1000 ppm Pb stock liquid and then putting it into a 100 mL volumetric flask. After that, it was added with distilled water until the etching mark was then shaken. After that, a standard solution of Pb was prepared with a concentration of 0.05 ppm; 0.1 ppm; 0.2 ppm; 0.3 ppm; 0.4 ppm; and 0.5 ppm. The maximum wavelength of the Pb analyzed by AAS is 283.3 nm (Dewi et al., 2021). The regression equation used in calculating Pb heavy metals can be seen in Figure 1(b).



(a) (b)

Figure 1. Calibration Curve of (a) Cu and (b) Pb

3. RESULTS AND ANALYSIS

The process of making nata de coco requires nutrients, such as carbon, hydrogen, nitrogen and minerals. Some of these nutrients are obtained from coconut water, carbon is obtained from sucrose, glucose, or fructose, while nitrogen is obtained from fertilizers, for example urea, ZA, and NPK fertilizers (Santosa Wirawan, 2021; Kholifah, 2010). Nitrogen in this inorganic fertilizer functions to activate the extracellular enzymes of the bacterium Acetobacter xylinum (Santosa et al., 2021). Inorganic fertilizers also contain other materials such as heavy metals Pb, Cd, Cr, Hg, Zn, As, Cu, and Mn (Alloway, 1995).

Heavy metals Cu and Pb in branded and bulk nata de coco come from nitrogen sources used for the propagation of Acetobacter xylinum. The nitrogen source is obtained from the non-food grade fertilizer used. Cu is a micro component in fertilizers, such as urea, NPK, and ZA (ammonium sulfate).

Cu is added to fertilizers to bind nitrogen elements so that plants can develop optimally. The role of Hu as a micronutrient in fertilizers is to maintain cell stability and resistance to fungal attack, a catalyst in photosynthesis and plant respiration, and the formation of plant enzymes.

BPOM (2015) states that metal residue caused by the addition of a nitrogen source can be removed through washing and heating processes. This process can reduce heavy metal content. However, there are some heavy metals that are still trapped in the extrapolysaccharide layer. Acetobacter xylinum cannot remove Cu heavy metal because the bacteria only uses nitrogen as a growth medium, while the heavy metal will remain in the nata de coco product. The extrapolysaccharide layer is a thin layer in the form of a gel or fine threads in the form of fibers. This layer is on the outside of the nata that coats the inside. Therefore, the heavy metals contained in nata de coco are not lost either in the boiling or washing process because they are in the coating.

3.1 Analysis of Copper

The results of Cu heavy metal analysis on branded and bulk nata de coco using AAS showed that the nata de coco contained Cu which did not exceed the threshold. The threshold used is that which has been regulated in SNI 01-4317-1996. The results of Cu heavy metal analysis in nata de coco can be seen in Table 1.

Table 1. Data from Analysis of Cu Heavy Metal Content in Nata de Coco

Sample	Metal	Result (mg/g)	Quality standards (mg/g) (SNI 01-4317-1996)
Branded bata *de coco*	Cu	0,00096	0,002
Bulk nata *de coco*	Cu	0,00096	0,002

In bulk nata de coco, Cu heavy metal contamination can come from the nitrogen source used. Bulk nata de coco is usually produced on a small scale or for households so it does not go through the process of washing and soaking before distribution. Meanwhile, branded nata de coco should not contain the heavy metal Cu because it has passed the test and received P-IRT. However, the analysis results contained Cu heavy metal even though it did not exceed the threshold. It is possible that Cu heavy metal contamination in branded nata de coco comes from the equipment used during the production process.

3.2 Analysis of Lead

The results of Pb heavy metal analysis on branded nata de coco using AAS showed that branded nata de coco did not detect the presence of heavy metal Pb. However, bulk nata de coco contained heavy metal Pb which exceeded the threshold of 0.0409 mg/g (>0.0002 mg/g). The results of Pb heavy metal analysis in nata de coco can be seen in Table 2.

Table 2. Data from Analysis of Pb Heavy Metal Content in Nata de Coco

Sample	Metal	Result (mg/g)	Quality standard (mg/g) (SNI 01-4317-1996)
Branded nata de coco	Pb	ttd	0,0002
Bulk nata de coco	Pb	0,0409	0,0002

Note: ttd = Not detected at AAS detection limit < 0.0001 ppm

The above data indicates that the branded nata de coco analyzed is safe from the dangers of metal Pb because its levels are below the threshold specified in SNI 01-4317-1996, which is 0.0002 mg/g. The process of making branded nata de coco or industrial packaging generally follows the SNI and is made in a sterile environment. The distribution permit has also been stated on the packaging of the nata de coco.

In bulk nata de coco, the heavy metal content of Pb which was detected was thought to have come from the use of newsprint to wrap nata de coco when it was fermented by nata de coco farmers (Kholifah, 2010). Asri and Wisanti (2017) also stated that the source of these heavy metals apart from newsprint also comes from the use of ZA and urea fertilizers which are added in the manufacturing process. Theoretically, ZA fertilizer does not contain heavy metals, but it is possible that the packaging and transportation processes are polluted by heavy metals (Asri & Wisanti, 2017).

3.3 Discussion

The branded nata de coco sample analyzed in this study did not detect the presence of heavy metal Pb with an AAS detection limit of less than 0.0001 ppm. Meanwhile, the sample contains Cu heavy metal of 0.00096 mg/g which is below the SNI threshold, so it is still safe for consumption. Even though the content is still below the threshold specified by SNI, excessive consumption of nata de coco can cause several health problems due to accumulation of the heavy metal Cu in the body.

One of the diseases caused by too much Cu in the body is Wilson's disease (Stern et al., 2007). The disease causes Cu in the liver to be unable to be excreted into the bile circulation or bound to ceruloplasmin. In addition, excessive Cu can also cause cancer and blood hemolysis.

The bulk nata de coco samples analyzed in this study contained Cu and Pb heavy metals. The content of Cu metal in the sample was 0.00096 mg/g which was still below the SNI threshold, but the Pb metal content in the sample was 0.0409 mg/g which exceeded the SNI threshold. These results indicate that the bulk nata de coco product analyzed is not safe for consumption. Even though the heavy metal content of Cu was still below the SNI threshold, the same sample contained heavy metal Pb which far exceeded the SNI threshold. Excessive or frequent consumption of bulk nata de coco products can cause headaches, tremors, hallucinations, neurological disorders, impaired kidney function, miscarriage, defects to fetal death, decreased hemoglobin (anemia), decreased concentration and intelligence (Adhani et al., 2017).

4. CONCLUSION

Based on this research, it can be concluded that the nata de coco samples analyzed using AAS, both branded and bulk, contained Cu heavy metal. However, Pb content is only found in bulk nata de coco. The heavy metal content of Cu in branded and bulk nata de coco was the same, which was 0.00096 mg/g, while the heavy metal content of Pb in bulk nata de coco was 0.0409 mg/g. Branded nata de coco does not contain the heavy metal Pb because the process of making nata de coco is in accordance with the standards. Meanwhile, the heavy metal content of Cu in nata de coco was still below the threshold specified in SNI 01-4317-1996, but the heavy metal content of Pb in bulk nata de coco far exceeded the threshold in SNI 01-4317-1996.

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