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Identification Of Mercury Levels in The Urine of Gold Processing Workers in Krueng Sabee Aceh Jaya District

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Abstract

Teknik amalgamation by involving mercury in the gold processing process is still widely used by gold miners in Indonesia, such as those in Paya Seumantok Village, Krueng Sabee District, Aceh Jaya Regency, so that it has the potential to threaten the health of workers. Therefore, in this study, mercury levels in the urine of workers at the gold processing plant in Paya Seumantok Village were identified. The sample in this study was the urine of all workers at the gold processing site, totaling 10 workers, the Analysis of mercury levels in the urine was carried out using the AAS instrument. Based on the Analysis results from 10 urine samples, 3 samples did not detect the presence of mercury, while the other 7 samples were identified as mercury. The average mercury content contained in the urine of gold processing workers is 5.80 µg / L, the minimum concentration of mercury in the urine of the people who have been successfully detected is 0.00 µg / L. In comparison, the maximum or highest concentration is 33.88 µg / L. Average mercury content in worker urine does not exceed the threshold based on the threshold value set by Human Biomonitoring (HBM) of 7 µg /L, however, from the results of the Analysis, several samples of worker urine had a urine content exceeding the threshold.

Keywords: *Urine, Workers, Gold, Mercury, Mine, Krueng.*

INTRODUCTION

Gold miners traditionally use the amalgamation method, which involves binding gold metal from chunk ore using heavy metals, such as mercury (Hg) (Andri et al., 2011). Mercury (Hg) is a metal that is biomagnified through the food chain and can transform into a more toxic organic form (metil-mercury, dimethyl-mercury, ethyl-mercury, and others) (Rianto, 2010).

Suhendrayatna et al., (2013) his research mentioned that merkuri is used in separating gold by folk and small-scale gold miners in Krueng Sabee. Miners put mercury and gold ore into the glass to extract gold by amalgamation. After the gold is isolated from its ore as amalgam, mercury is evaporated by burning with a simple oil stove. Some mercury used in this process is released directly into the environment. Actively operating gold processing Units contributed to the achievement of the highest mercury emissions (173.58 g/m3) compared to stand-by gold processing units (33.35 g/m3) and inactive processing units (2.54 g/m3). The concentration of mercury emissions in the ambient air depends on the height of the sampling point from the soil surface. The mercury content is more significant at a 30-50 cm height compared to 100-150 cm.

Rice et al. (2014) suggest that mercury exists in nature naturally and there are as many contaminants as a result of human activity; the release of mercury into the environment can lead to a progressive increase in the amount of mercury in nature that can enter the cycle of distribution of air, soil, and water where mercury can remain in the environment for many years. Mercury poisoning results from exposure to mercury or mercury compounds, resulting in various toxic effects depending on the chemical form and route of exposure. The main route of human exposure to methyl merkyouri (MeHg) is mostly through eating contaminated fish, seafood, and wildlife exposed to mercury through the consumption of contaminated low organisms. MeHg

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toxicity is associated with nervous system damage in adults and neurological developmental disorders in infants and children. Ingested mercury can undergo bioaccumulation, which causes a progressive increase in the body's load.

Measurements of body tissues called biomarkers will help assess exposure to pollutants. One of the biomarkers that can be used to assess mercury exposure in the body is to measure urine samples. Baeuml et al. (2011) stated that urine is a good biomarker for determining acute exposure to inorganic mercury. Based on the results of monitoring of Artisanal Smal l-Scale Gold Mining (ASGM) workers at 6 ASGM points in the Asian and African regions, the highest maximum mercury content in the urine of workers was found from ASGM workers in Indonesia-Kalimantan, namely 5,240 µg / L urine-mercury and 1,697 µg / g creatinine. Another study conducted by Yard et al., (2012) stated that there was a difference in the value of mercury constellation in the urine of workers who worked in the amalgam combustion section with non-breeding workersaran amalgam. In workers of aran amalgam, it was found that the constituency of mercury in the urine was higher than that of non-amalgam burners.

From the preliminary survey results, it is known that the gold processing activities carried out in Paya Seumantok Village are still traditional and use amalgamation techniques that use mercury in the processing process. The gold ore mined in the Mountain area of Krueng Sabee district is ground with a rolling pin that has been added with mercury until it becomes sand powder, then mixed with mercury and pressed with cloth until it becomes powder. Mercury sand and water come out of the pores of the fabric. Then, proceed to ignite or ignite the filament, then hammer. From an environmental point of view, sources of pollution can appear at any stage of gold processing. At the destruction stage, the element mercury can be released from the coils so that it falls, pollutes the surrounding soil, and pollutes the river. At the washing and squeezing stage, liquid waste containing mercury from the operation can be scattered around the gold processing area, polluting the soil. In addition, during the combustion phase, mercury vapor from this operation can pollute the air and settle on the soil's surface. This study aims to determine the concentration of mercury in the urine of the community and gold processing workers by amalgamation.

RESEARCH METHODOLOGY

Time and Place of Research

This research was conducted at the Environmental Quality Analysis laboratory of the Department of Chemical Engineering, Faculty of Engineering, Syiah Kuala Banda Aceh University in May-August 2021. Urine samples in this study were taken from workers and communities around the community gold processing plant in Paya Seumantok Village, Krueng Sabee District, Aceh Jaya Regency.

Sample

The urine sample to be taken is the urine of the worker. Ten workers' urine samples will be taken using the total sampling method.

Urine Sampling Procedure

Carrying out urine samples of workers and urine of the community follows the Regulation of the Minister of Health Number 43 of 2013, the following is the procedure for taking urine samples:

In women

In the collection of the middle portion of urine specimens carried out by the sufferer himself, previously an explanation must be given as follows:

Respondents should wash their hands with soap and then dry them with a towel;

Take off the underwear, spread the labia with one hand;

Clean the labia and vulva using sterile gauze in the direction from front to back;

Rinse with warm water and dry with another sterile gauze;

During this process, remove the urine, the first outflow of urine is discarded. The flow of urine is then accommodated in the container that has been provided;

Avoid urin hitting the edge layer of the container;

Collection of urine essay cells before the flow of urine is exhausted;

The container is tightly closed and immediately delivered to the laboratory.

In Males

Patients with harus wash their hands with soap;

If it is not circumcised, pull the skin of the prepuce back and remove the urine. The flow of the first one out is removed, and the flow of urine is then accommodated in a container that has been provided. Avoid urine hitting the edge layer of the container. The collection of urine is completed before the flow of urine is exhausted;

The container is tightly closed and immediately sent to the laboratory.

In infants and Children

Respondents were previously given to drink to facilitate urination;

Clean the genital apparatus as explained above;

Urine retrieval is carried out by:

The child sits on the nurse's lap;

Encourage the child to excrete urine, and collect the urine in a sterile plastic container or bag;

Babies are fitted with urine-holding sacs on the genital apparatus.

The sample bottle is then put in a box where the urine sample is stored so it is not contaminated with other metals.

Sample Storage

Urine samples before the measurement process using a cold steam Atomic Absorption Spectrophotometer or Mercury Analyzer are first carried out preservation that follows the Indonesian National Standard (SNI) with the following specifications:

Container: Plastic bottle (polyethylene) or glass bottle that has been rinsed with HNO3 1:1;

Preservatives: Acidify with HNO3 to pH ≤ 2;

Storage Time: 14 days Plastic Bottle or 30-day glass bottle; and

Storage Conditions: 4°C ± 2°C.

Identification of Mercury Levels in the Urine

Ethical Approval

The protocols in this research had ethical approval No. 2559/IV/SP/2021 (date 10 April 2021) from the Faculty of Nersing, Nort Sumatra University, Medan, Indonesia. The urine and human dieses application for this research, based on the standard method, was chosen with the approval of the ethic committee.

Results of Examination of Mercury Levels in Workers' urine

Identification of mercury levels in the urine of gold processing workers was carried out using the AAS instrument, the Analysis was carried out in the laboratory of Environmental Quality Analysis Engineering, Department of Chemical Engineering, Faculty of Engineering, Syiah Kuala University, Banda Aceh. Before measuring the urine test sample, measurements are taken to make a calibration curve, the following figure shows the calibration curve of the mercury standard measurement results.

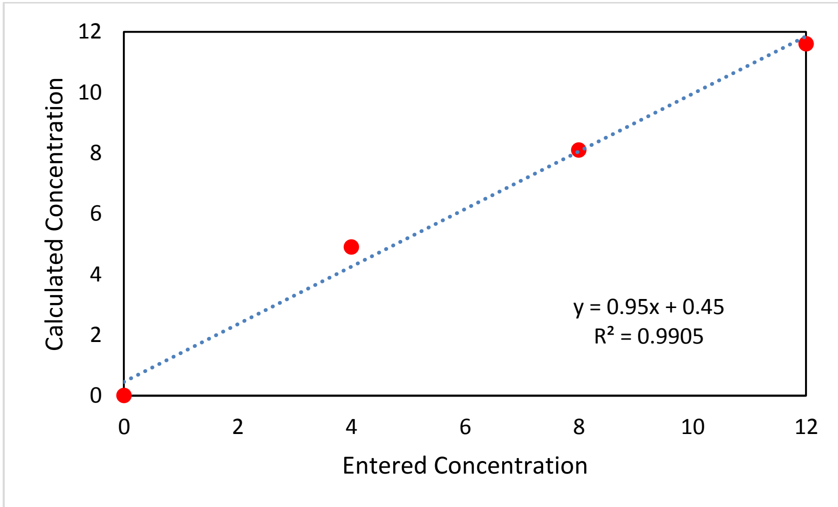

Figure 5.1. Calibration Curve

Based on Figure 5.1, the value of r is 0.9905. This indicates that the curve formed is linear enough to indicate that the tool can work properly. Ten urine samples were collected in total. Table 5.2 shows the results of the Analysis of mercury levels in the community's urine.

Test Sample Measurement

Urine samples that have been prepared previously will be measured for mercury levels, The sample is tested with reference to SNI 6989.78-2011 on how to test mercury (Hg) by Atomic Absorption Spectrophotometry (SSA)-cold steam. The test method is as follows:

Put 100 mL of sample or sample that has been diluted and is within the measurement range into the Erlenmeyer 250 mL;

Put 100 mL blanks and 3 standard working solutions into each Erlenmeyer 250 mL;

Added 5 mL H2SO4 concentrated and 2.5 mL HNO3 concentrated into each Erlenmeyer;

Added 15 mL of KMnO4 solution and wait up to 15 minutes (when the purple color is lost, KMnO 4 is added again until the purple color does not disappear);

Added 8 mL K2S2O8 and heat in a water bath for 2 hours at 95°C;

Cooled to room temperature;

Added to taste hydroxylamine-NaCl solution to reduce excess KMnO4;

5 mL SnCl2 was added, and absorption was immediately measured using an optimized cold steam Atomic Absorption Spectrophotometer according to the tool instructions.

RESULTS

Identification of Mercury Levels In The Urine Of Workers Around The Mine

People's Gold

This research was conducted at one of the traditional gold processing sites in desa Paya Seumantok Krueng Sabee District, Aceh Jaya Regency, which has been running for over 10 years. This gold processing place runs actively, and almost every day, the gold processing process is carried out by the amalgamation method, which uses mercury. What was mentioned in the previous chapter is that mercury has a harmful impact on the environment and also on human health. Therefore, this study was carried out to determine the picture of disease symptoms experienced by workers at the gold processing site so that this information can be the basis for the next research stage, namely measuring mercury levels in workers.

Results of Examination of Mercury Levels in Workers' urine

The identification of mercury levels in the urine of gold processing workers is carried out using AAS instruments. The Analysis was carried out in the Environmental Quality Analysis Engineering laboratory, Department of Chemical Engineering, Faculty of Engineering, Syiah Kuala University, Banda Aceh. Before measuring the urine test sample, measurements are first taken to create a calibration curve. The figure shows the attached calibration curve.

Based on the calibration curve with the value of r is 0.9905, this indicates that the curve formed is linear enough to indicate that the tool can work properly. A total of 10 urine samples were collected. Table 4.2 shows the results of Analysis of mercury levels in people's urine.

Table 4.2. Mercury (Hg) (µg/L) Level Analysis Results

No.	nts	Average (µg/L)
1		0.00 ± 0.00
2		0.17 ± 0.29
3		2.02 ± 1.54
4		0.00 ± 0.00
5		0.00 ± 0.00
6		2.88 ± 1.34
7		12.87 ± 3.61
8		3.95 ± 1.24
9		33.88 ± 0.64
10		2.31 ± 0.11

Table 4.3 shows the results of the description of the Analysis of mercury levels in the urine of traditional gold processing workers.

Table 4.3 Description of results Analystsare mercury levels in workers' urine (n=10)

	ion		**Sum (µg/L)**
			5.80
			2.16
	ion		10.59
	level		0.00
	Rate		33.88
	s		.00
			2.16
			6.18

Table 4.3 shows that the average mercury content in the urine of the communities around the gold processing site is 5.80 µg/L, with a standard deviation of 10.59 µg/L. The minimumm concentration of mercury in the urine of the people who were successfully detected was 0.00 µg/L, while the maximum or highest concentration was 33.88 µg/L.

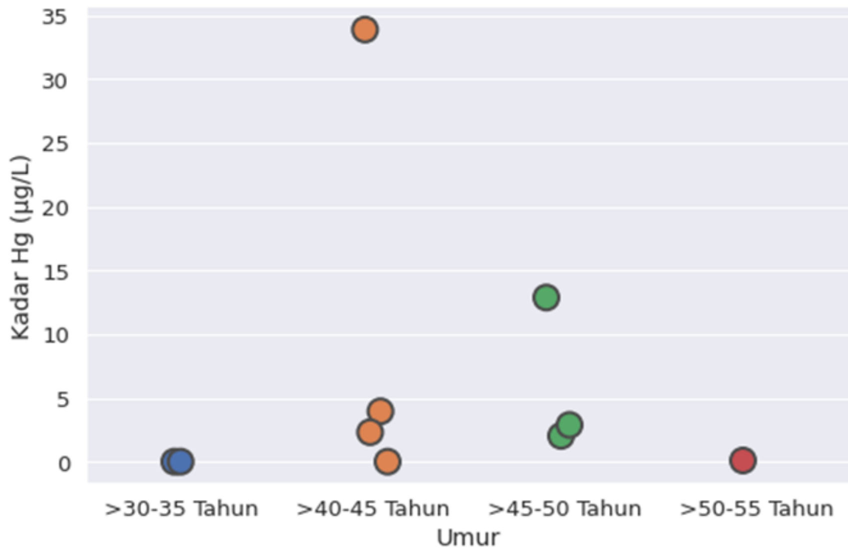

Figure 4. 1. Distribution of mercury concentrations based on the age of respondents

Based on the information in Figure 4. 1, the highest concentration of mercury in the urine occurs in the 40-50 age range. Figure 4. 2 indicates the distribution of mercury levels in the urine of workers based on their education level.

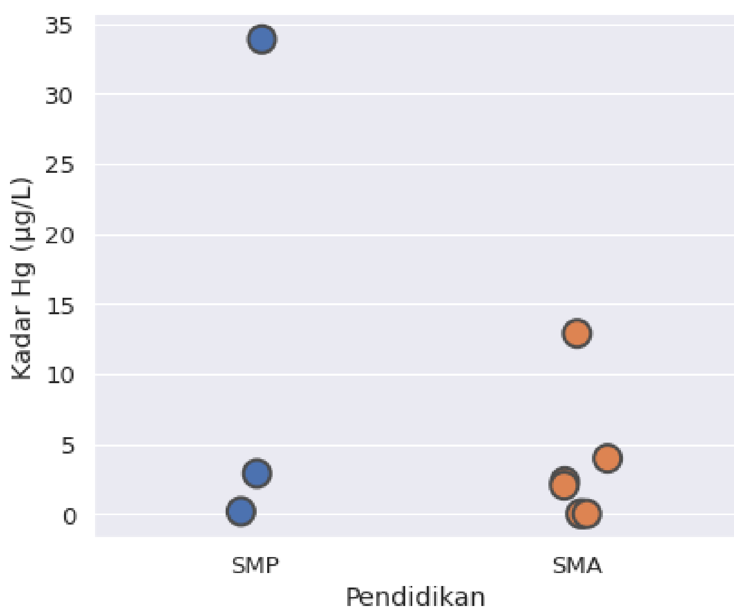

Figure 4. 2. Distribution of mercury concentrations based on Worker Education

Figure 4. 2 indicates the concentration of mercury in workers' urine based on their education level. In general, all workers are educated in middle and high schools. Based on the study's results, 1 worker with a junior high school education had the highest level of mercury in the urine, which was 33.88 µg / L. Figure 4. 3 shows the distribution of mercury levels in workers' urine based on the length of time worked.

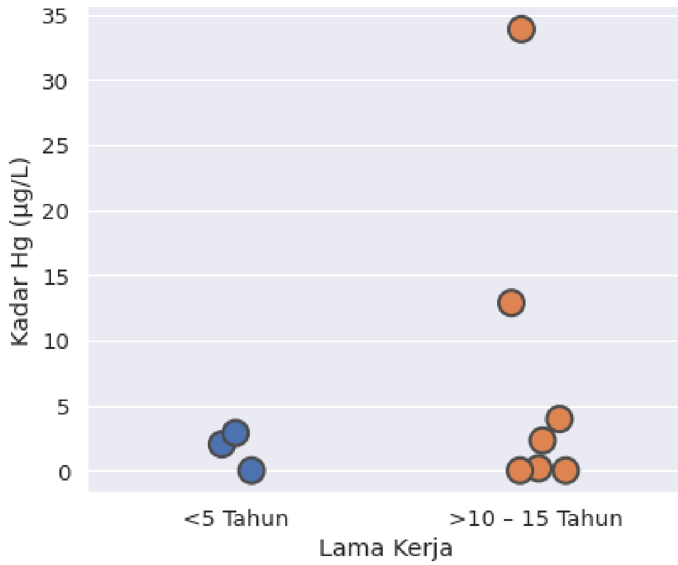

Figure 4. 3 Distribution of mercury concentrations based on length of time kerja

Based on Figure 4. 3, it can be seen that the length of time the worker has worked affects the level of mercury in the worker's urine. The service period above 10 years indicates a tendency to increase the level of mercury in the urine.

DISCUSSION

Identification of Mercury Levels in The Urine Of Workers Around The Mine

People's Gold

The results of the Analysis of mercury levels in the urine of workers show that the average mercury content contained in the urine of gold processing workers is 5.80 µg / L with a standard deviation of 10.59 µg / L. The minimum mercury concentration in the urine of the people detected is 0.00 µg / L, while the maximum concentration of the highest is 33.88 µg / L. Rata-average.

The mercury content in workers' urine does not exceed the threshold based on the threshold value set by Human Biomonitoring (HBM) of 7 µg / L (Schulz et al., 2007). However, the analysis results show that several samples of worker urine have mercury content that exceeds the threshold. Figure 4. 11 indicates the number of urine samples with mercury levels exceeding a predetermined threshold.

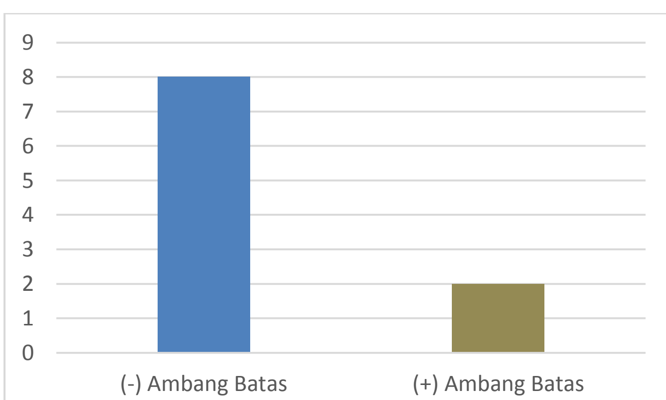

Figure 4. 4 Mercury levels in the urine of workers who exceed the threshold

Based on Figure 4. 11, from 10 urine samples, 2 urine samples had mercury levels exceeding the predetermined threshold. Based on the study of the characteristics of respondents, the high concentration of mercury in the urine is related to the level length of working time, as shown in Figure 4.9. This is supported by Li et al., (2009), who stated that mercury apparatus for a long time increases the concentration of mercury content in the body, besides that it also causes the occurrence of acute and chronic toxicity. Similar research has also been previously reported by Hartini (2007) to have also conducted research on gold miners in Rengas village, Titi district, Ketapang regency. From the study results, the average amount of mercury levels in the urine in miners was 7.6 μg / L and exceeded the normal threshold value.

Based on research conducted by Lestarisa on gold miners in Kurun District, Gunung Mas Prov Regency, Central Kalimantan experienced Mercury (Hg) poisoning as much as 90.9% because of the > 10 years of service. Long work allows gold miners to experience exposure to mercury (Hg) so that they are at risk of accumulating mercury in their bodies (Lestarisa, 2010). Another study stated that based on the results of research in Panton Luas Village, Sawang District, South Aceh, it was disputed that the majority of gold miners' ages were aged 20-30 years, then the highest was elementary school (60%), then from the results of the Analysis of gold miners the most was between 1-4 hours/day, namely 12 people (40%) with a work duration between 2-3 (46.7%). The average level of mercury (Hg) in the urine in gold miners in Panton Luas Village, Sawang District, South Aceh Regency, was 2.82 g/l (SD±0.57) (Harianto Bangun, 2015). For some previously related researchers, it can be concluded that the concentration of mercury in the urine of gold processing workers is affected by the length of service life.

Other studies conducted by Tsuji et al (2003), who conducted a combined analysis to investigate the relationship between exposure to elemental mercury in the air and the resulting urinary mercury levels, in particular at lower air levels relevant for environmental exposure and public health purposes (i.e., <50 μg/m3 to 1.0 μg/m3). Ten studies reporting data on mercury and urine in pairs (a total of 149 samples) met the data's quality and adequacy criteria. The log-transformed data set showed a strong correlation between mercury in the air and urine (r = 0.774), although the relationship best matched a series of parallel lines with different interceptions for each study R2 = 0.807). The predicted ratio of air-to-urine mercury levels at an air concentration of 50 μg/m3 ranged from 1:1 to 1:3, based on regression lines for the study. Towards the lower end of the data set (i.e., 10 μg/m3), the predicted urinary mercury levels cover two ranges: 20 μg/L and 30-60 μg/L. Extrapolation to 1 μg/m3 results in predictions of urine levels of 4-5 and 6-13 μg/L. Some studies associate higher prediction rates with static area air samplers rather than more accurate personal air samples. Predictions of urinary mercury based primarily on personal air samplers at 1 and 10 μg/m3 are consistent with reported average background levels (4 μg/L) and upper limits (20 μg/L). Thus, although mercury levels in the air and urine correlate below 50 μg/m3, the impact of mercury levels in the air below 10 μg/m3 is likely indistinguishable from urinary mercury levels.

The primary chemical forms of mercury are elemental mercury, inorganic divalent mercury, and methyl mercury, which are metabolized in different ways and have different toxic effects on humans. Among the various chemical forms of mercury, methylmercury is known to be highly neurotoxic and has been identified as the cause of Minamata disease. It is bioaccuminated in fish and shellfish through the aquatic food web, and fish and marine mammals at high trophic levels show high mercury concentrations. Most human methylmercury exposure occurs through seafood consumption. Metil mercury easily penetrates the blood-brain barrier, so it can affect the nervous system. Fetuses are known to be at high risk of exposure to methylmercury (Sakamoto et al., 2018).

Asmall amount of elemental mercury (Hgo) enters the human body through the skin or oral contact, and about 80% of mercury vapor enters the body through inhalation. When the amalgam is heated, anyone around the combustion site can be exposed to mercury vapor the combustion acid. Several types of research about mining activities in Indonesia against the decline in river quality and health risks that may occur have been widely carried out. Subanri (2008) stated that there is a significant relationship between the mining distance and the mercury content found at the mining site, the longer the distance the smaller the Hg level in the water. In addition, Rianto (2010) stated that although the mercury level in the blood of mine workers exceeded the permissible limit, there were no symptoms or health problems experienced by the mine workers. However, the presence of mercury content in the worker's blood can be an indicator that mercury compounds have entered the body and will undergo biotransformation, which will become metabolites and some will to the target organs such as saraf, kidneys, and other target organs.

The mercury content in urine is not only found in gold processing workers; previous studies have also found gold content in the urine of people who use whitening creams (Elfia, 2020). Previous research has also found several symptoms of acute and chronic diseases in gold processing workers. The symptoms of these diseases could be influenced by the accumulation of mercury in the body, which is the cause.

CONCLUSION

Based on the results of the Analysis carried out from 10 samples of worker urine, 3 samples have not detected the presence of mercury, rata-average mercury levels contained in the urine of gold processing workers were 5.80 μg / L, the minimum concentration of mercury in the urine of the people who were successfully detected was 0.00 μg / L, while th e maximum or highest concentration was 33.88 μg / L. Average mercury content in the urine of workers did not exceed the threshold based on the threshold value that set by Human Biomonitoring (HBM) of 7 μg/L.

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