

Mercury Levels in the River Water and Urine of Traditional Gold Miners in Hulawa Village East Sumalata District North Gorontalo Regency

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Abstract: Gold mining process with mercury is conducted by separating gold from the sands through amalgamation process and combustion process mostly conducted by group of traditional gold miners. This research aims to know mercury levels correlation in the river water and urine of traditional gold miners. This research used research design of analytical survey with cross sectional study approach to be analyzed using pearson correlation test. The research result showed that there were 2 rivers with mercury levels of 0.0213-0.0183 ppm respectively in which it did not met the requirement of threshold value while the urine sample that been tested in this research met the requirement of threshold value. Based on the result if pearson correlation analysis, it was obtained $r = 0.073$, then correlation of mercury levels in the river water and urine of traditional gold miners was in very low category. It is suggested to the gold miners in which they should not dispose mining waste to the river without waste treatment process first in order to not damage the environment around such as river ecosystem and people around.

Key words: Mercury (Hg), river water, urine of miners, traditional gold miners, environmental effect

INTRODUCTION

In Indonesia, heavy metal pollution (Widianarko *et al.*, 2000) tends to increase as with the increase of industrialization process (Li *et al.*, 2014, 2015). Since, industrialization era, mercury (Villalba *et al.*, 2015) becomes excavation pollutant material due to mercury can be used as maximum as possible (Bavec *et al.*, 2015). One of cause to the environmental pollution by mercury (Riaz *et al.*, 2016) is tailing disposal of gold processing (Veiga *et al.*, 2014a, b, 2015) which processed in amalgamation way (Garcia *et al.*, 2015).

The effect of mercury (Hg) to the health (Parsons and Percival, 2005) depends on its compound form (Branco *et al.*, 2014). Inorganic Hg compound (Rose *et al.*, 2015) and metallic Hg compound (Rumayor *et al.*, 2013) according to International Agency for Research on Cancer (IARC) included into group 3 which hazardous materials which don't cause cancer to human while methylmercury and its compounds included into group of 2B which is hazardous materials which can be carcinogenic to human. Mercury has neuro-toxic properties which is toxic to the central nervous system (Central Nervous System-CNS) (Inswiarsi and Kusnoprantoro, 2011).

Gold mining in Hulawa village, East Sumalata District, North Gorontalo Regency is unorganized gold mining location (Male *at al.*, 2013) or known as Illegal Gold Mining (PETI-Penambangan Emas Tanpa Izin

(Dutu, 2016). Processing method in this mining performed in traditional way through amalgamation process (Veiga *et al.*, 2015) with simple tools (Drevnick *et al.*, 2016). This mining activity uses mercury as main material in separating gold (Appel and Na-Oy, 2014). All activities that conducted by miners do not use any Personal Protective Equipment (PPE) (Arezes and Miguel, 2013) which can protect themselves from chemical compound exposure (Dhal *et al.*, 2013). From all gold mining locations, the oldest location is in Hulawa village. It is due to this mining location was established since Dutch East Indies era (GGP, 2008).

Hulawa river is water source for people (Ngoye and Machiwa, 2004) in Hulawa village. Hulawa river functioned as conservation area (Khamis *et al.*, 2014) which managed to maintain condition around river flow area in order to not be degraded (Abell *et al.*, 2007). For people in East Sumalata District, Hulawa river used for social and economic interests, agriculture needs, clean water and fishery. This river (Everard and McInnes, 2013) includes into subsequent-permanent type with (V) shape. Hulawa river flows from West to East and ended in Sumalata Gulf. Around the boundary of Hulawa river, there are people settlements and Illegal Gold Mining activities in which the waste goes into the Hulawa river and ended in Sulawesi Sea (ERITAGP, 2013).

According to the research result that been conducted by Regional Environmental Agency (BLH) of North

Gorontalo Regency, it was found that from 30 miner samples that been taken, 100% suffered by mercury toxic (Li *et al.*, 2015) with nail bio-marker shows levels above threshold value which is 1-2 mg kg⁻¹.

Based on another research result that conducted by (Wardiyatun and Hartini, 2009) which was about miners in Rengas Tujuh Village Tumbang Titi District Ketapang Regency West Kalimantan Province, showed that 44.4% (8 people) miners in Rengas Tujuh Village contaminated by mercury in their urine sample with mercury levels of 2.32-45.29 g L⁻¹ and the average mercury level was 7.6 g L⁻¹. There were 3 gold miners who had mercury levels above the threshold value (NAB) in their urine sample. The research that conducted by Gafur and Jahja showed that mercury levels in Hulawa river was 0.0284 ppm and according to the Ministry of Health Regulation in 2001, heavy metal levels that allowed in the water body is 0.001 ppm.

MATERIALS AND METHODS

Research location and design: This research was conducted in Bukit Pasolo Gold Mining, Hulawa village, East Sumalata District, North Gorontalo Regency. Sample test was conducted in Physics Laboratory in the State University of Gorontalo and this research design used analytical survey (Frank, 1996) with cross sectional study (Barnett *et al.*, 2012) approach to study about correlation dynamics between risk and effect factors by observation approach or data collection all at once in a time (Notoatmodjo, 2010).

Research population and sample: Population in this research was all gold miners in traditional gold mining location of Hulawa village for 30 people and sample in this research was river water and miner's urine. Sample taking technique in this research was conducted by using purposive sampling technique (Topp *et al.*, 2004).

Data analysis: Analysis of correlation coefficient used to know the level of correlation for mercury levels in the river water as X variable and urine of gold miners as Y variable by using pearson product moment (Sugiyono, 2008). The equation of pearson correlation can be seen in the equation:

$$r_{xy} = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)}}$$

Where:

- r = Pearson correlation coefficient
- x = Independent variable
- y = Dependent variable
- n = Number of sample

RESULTS

Mercury (Hg) levels in the river water: Sample taking of river water was performed in the established location which was in river location as direct disposal location of gold processing waste using mercury. Sample was taken in 5 areas and then conducted by test in Physics Laboratory State University of Gorontalo (Table 1).

From the test result of mercury levels in Physics Laboratory State University of Gorontalo to the river water around gold mining location, it was obtained the result of sample code 01 was 0.0213 ppm in which it was the highest mercury levels and sample code 05 obtained 0.0001 ppm where it was the lowest mercury levels. According to the Ministry of Health Regulation No. 416/Ministry of Health/Regulation/IX/1990: threshold level of mercury levels to the river water is 0.001 ppm.

Mercury (Hg) levels in the miner's urine: Urine sample taken from traditional gold miners in Hulawa village, East Sumalata District, North Gorontalo Regency (Table 2). From the result of mercury levels test to the urine sample of gold miners, it was obtained that 5 tested urine sample had mercury levels which still in the tolerance of threshold value where the highest mercury levels was respondent A with 0.0040 ppm and the lowest mercury levels was respondent D with 0.0010 ppm. Based on standard that established by WHO threshold value of mercury levels in the human urine is 0.004 ppm.

Table 1: The result of mercury (Hg) levels test in the river water

Sample code	The result of mercury levels the river water (ppm)	Explanation	Standard of ministry of health regulation
01	0.0213	TMS	Threshold value of mercury levels in the river water is 0.001 ppm
02	0.0183	TMS	
03	0.0013	MS	
04	0.0003	MS	
05	0.0001	MS	

Table 2: The result of mercury levels test to the gold miner's urine

Respondent	The result of mercury levels in the urine (ppm)	Explanation	Standard of WHO
A	0.0040	MS	The average threshold value of mercury levels in the human's urine is 0.004 ppm
B	0.0021	MS	
C	0.0033	MS	
D	0.0010	MS	
E	0.0011	MS	

Level of correlation for mercury levels in the river water and urine of gold miners:

Based on the result of pearson correlation analysis by using the assistance of SPSS which aims to know level of correlation for mercury levels in the river water and urine of traditional gold miners, it was obtained that correlation coefficient value $r = 0.073$. If it is related with Table 1 to make correlation coefficient interpretation then level of correlation for mercury levels in the river water and urine of gold miners in Hulawa Village East Sumalata District North Gorontalo Regency was in very low category.

DISCUSSION

Mercury levels in the river water: Mercury is heavy metal that mostly used by human in many activities (Cao *et al.*, 2015) such as traditional gold mining activity (Appel and Na-Oy, 2014). Mercury used to separate gold from other materials.

Gold mining in Hulawa village still uses traditional processing method which is through amalgamation process with very simple tools (Veiga *et al.*, 2014). Amalgamation process is gold processing by mixing gold ore with liquid mercury. Amalgamation process that conducted by gold miners in Hulawa village for years have caused river pollution by mercury around the mining location in which excavation process that conducted along with amalgamation process have caused mercury washing process in the residue goes into the river. It is in line with the statement of Kiefer *et al.* (2014) that “gold mining with amalgamation technique is predicted to be mercury contamination around its area”.

In this research, the researcher used Hulawa river water as research sample. Sample was taken in 5 sample areas in the direct disposal location of mining waste. It was taken from the furthest area to the nearest area such in Fig. 1.

From the test result that conducted in Physics Laboratory State University of Gorontalo, mercury levels in the river water around gold mining location was obtained result of 0.0213 for sample 01 in which it was the highest mercury levels and 0.0001 ppm for sample 05 in which it was the lowest mercury levels. According to the Ministry of Health Regulation No. 416/Ministry of Health/Regulation/IX/1990: threshold level of mercury levels to the river water is 0.001 ppm.

It was affected by the distance of sample taking area. This research result was in line with Foucher *et al.* (2013) which showed that distance of mining location determines level of mercury concentration which accumulated in sediment where the nearer distance of mining location, the higher mercury concentration compared with location



Fig. 1: Location of the river Hulawa seemed satellite and 5 points of mining waste samples from the closest point to the mine site to the farthest point

which far from mining location. The nearest sample to mining location in this research was sample 01 with mercury levels above threshold value which was 0.0213 ppm and sample 05 had mercury levels decrease with mercury levels of 0.0001 in which it was the furthest sample to mining location.

Mercury levels in the urine of gold miners: Contact between mercury and individu can be occurred through skin inhalation (Sun *et al.*, 2013) or digestion (swallowed) (Martinez *et al.*, 2015) which then adsorbed and distributed by blood to all body parts and finally it will have excretion process through the route of urine, sweat, saliva, breast milk, feces, nail and hair.

From the test result that conducted in Physics Laboratory State University of Gorontalo, mercury levels in the urine of gold miners showed that 5 studied urine samples had mercury levels in tolerance levels where the highest mercury levels was respondent A for 0.0040 ppm and the lowest was respondent D for 0.0010 ppm. Based on standard that been established by WHO the average threshold value of mercury levels in human urine is 0.004 ppm.

The difference mercury level in the urine of gold miners was affected by many factors such as age and working period. Respondent A had mercury levels in the urine for 0.0040 ppm which was higher than other respondents due to respondent A was older (43 years old) with longer working period (4 years) compared to respondent D who had mercury levels in the urine for 0.0010 ppm. Respondent D had the lowest mercury levels in the urine due to respondent D was still young (26 years old) with shorter working period (3 years).

It was in line with the research of (Solenkova *et al.*, 2014), Hg concentration also affected by other factors such as exposure duration (working period), Hg compound form in the body, Hg dosage which adsorbed

in the body, metabolism ability (organ performance and function) and age in which age supports in excreting toxic in the body.

Level of correlation for mercury levels in the river water and urine of gold miners: Mercury is one of heavy metal which can be organic (Khan *et al.*, 2013) and inorganic (MacDonald *et al.*, 2015) compound and it is mostly found in the nature and distributed in the rocks, mine ore, soil, water and air. Mercury is kind of metal which in normal condition it is liquid with grey color and odorless. Mercury has properties of easy to evaporate in room temperature and can be solid in the pressure of 7640 atm (Junita, 2013).

After conducted by test of mercury levels in the river water and urine of gold miners in Physics Laboratory State University of Gorontalo, then the test result was analyzed based on pearson correlation using SPSS application which aims to know level of correlation for mercury levels in the river water and urine of traditional gold miners. It was obtained correlation coefficient value $r = 0.073$ in which $r > 0$ means there was linear and positive relationship which was the larger X variable the larger Y variable. If it is seen from r value and correlated with Table 1 for correlation coefficient interpretation, then it would be obtained that level of correlation for mercury levels in the river water and urine of traditional gold miners in Hulawa Village East Sumalata District North Gorontalo Regency was included into very low category.

CONCLUSION

Mercury levels in the river water around gold mining location in Hulawa Village East Sumalata District North Gorontalo Regency was obtained 2 samples that did not met the requirement of threshold value of mercury levels. They were sample 01 and sample 02 with the mercury levels of 0.0213-0.0183 ppm, respectively. Sample 01 had the highest mercury levels of 0.0213 ppm and sample 05 had the lowest mercury levels of 0.0001 ppm. According to the Ministry of Health Regulation No. 416/Ministry of Health/Regulation/TX/1990: threshold level of mercury levels to the river water is 0.001 ppm.

Mercury levels in the urine of gold miners in Hulawa Village East Sumalata District North Gorontalo Regency was obtained 5 studied urine samples in which those samples were still in tolerance range. The highest mercury levels was in respondent A for 0.0040 ppm and the lowest mercury levels was in respondent D for 0.0010 ppm. Based on standard that been established by WHO the average threshold value of mercury levels in human urine is 0.004 ppm.

It is expected that Government of North Gorontalo Regency able to manage the condition before the large effect comes to the people and environment around mining location. And the miners are expected to use personal protective equipment during the mining works and should not dispose mining waste directly to the river body without any waste treatment first.

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