DETECTION OF THE LEAD CONTAMINATION LEVEL IN THE ENVIRONMENT USING CATTLE AS A BIOINDICATOR

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Abstract

Environmental pollution by lead is suspected to be increasing, both in the plants, soil, and water. The lead contamination in plants will spread to livestock production and then to humans. The aim of the study was to examine the level of lead contamination in the blood of cattle associated with the level of contamination in the soil and water at the location where the cattle were kept. Cattle blood samples were taken by purposive sampling method in each Regency in Bali, accompanied by soil and water samples from this location. Examination of cattle blood, soil and water samples was carried out for the presence of lead using the atomic absorption spectrometry (AAS) method, at the Analytical Laboratory of Udayana University. The results of the examination of 270 samples of cattle blood, obtained the results of 20 cattle exposed to lead with an average of 0.109 ± 0.080 ppm. Examination of lead contamination at 20 exposed cattle farm locations obtained lead content data of 0.239±0.136 ppm in soil and 0.192±0.894 in water, respectively. The level of lead contamination in the soil and water are higher than that of cattle blood. Regression test showed that lead levels in cattle blood can be a predictor of lead contamination in soil and water. on the cattle farm. The conclusion is the presence of lead heavy metal contamination in cattle blood can be used as a bioindicator of lead heavy metal pollution in the soil and drinking water environment.

Keywords: cattle blood, lead, soil, water

1 INTRODUCTION

The health status of cattle is largely determined by the source of feed and water of the environment. With the narrower land for cattle grazing in Bali, many breeders allow cows to find food in landfills. The results of research on cows kept in the final disposal site (TPA) of garbage in Suwung, Denpasar City, found that there was heavy metal contamination of lead in their blood and some of them were also contaminated with cadmium (Cd) [1]. The same cases were also reported in TPA Jatibarang Semarang [2] Surakarta [3] Deli Serdang [4].

Lead heavy metal is extremely dangerous to animal and human health. Lead heavy metal poisoning can generally cause brain degeneration [5] and anaemia [6] and wasting of the liver accompanied by intranuclear inclusion bodies in hepatocytes [7]. The lead poisoning in ruminants causes symptoms of gastroenteritis, anaemia, and encephalopathy [4]. Hepatotoxicity due to toxicity originating from inorganic substances, can lead to decreased immunity to infectious agents [8]. Cadmium heavy metal poisoning can cause impaired kidney function [6].

The accumulative nature of lead heavy metals in body tissues is a worrying factor because heavy metals in the body are difficult to metabolize. Although there is a maximum threshold for lead content in meat at 1.00 ppm [9], efforts to free cattle from lead heavy metal contamination must be continued. This study aims to determine the relationship between lead heavy metal contamination in cattle blood, soil and drinking water, to further determine the role of cattle as environmental bioindicators.

2 METHODOLOGY

A total of 270 cattle blood samples were used in this study including soil and drinking water samples in the cattle area. The cattle, whose blood is sampled, are selected based on the location of the farm in the vicinity of the worst-predicted environment. Blood is drawn from the jugular vein aseptically. The lead heavy metal content in blood, soil

and drinking water samples were measured by the atomic absorption spectrometry (AAS) method [10]. Each of the samples were divided into two parts, 0.5 mL for positive control and 0.5 mL for the sample. Added 0.25 mL of 1 mg / l standard solution to the sample to make spiked or positive control. Spiked is evaporated on a hot plate at 100 ºC until dry. The sample and spiked are put into an ashing furnace and cover half of the surface. The temperature of the ashing furnace is gradually increased by 100 ºC every 30 minutes until it reaches 450 ºC and is maintained for 18 hours.
The sample and spiked were removed from the ashing furnace and cooled to room temperature. After chilling, 1 mL of HNO_3 65% was added, shaken carefully so that all the ash dissolved in the acid and then evaporated on a hot plate at 100 ºC until dry. After drying the sample and spiked are put back into the ashing furnace. The temperature is gradually increased by 100 ºC every 30 minutes until it reaches 450 ºC and is maintained for 3 hours. After the ash is completely white, the sample and spiked are cooled at room temperature. 5 mL of 6 M HCl was added to each sample and the spiked was carefully shaken so that all the ash dissolved in the acid. Evaporated on a hot plate at 100 ºC until dry. 10 mL of 0.1 M HNO_3 was added and cooled at room temperature for 1 hour, the solution was transferred to a 50 mL polypropylene measuring flask and added to the matrix modifier solution, adjusting it to the boundary mark using 0.1 M HNO_3. The working standard lead solution was prepared respectively. A minimum of five concentration points each. Standard working, sample, and spiked solutions were read on a graphite fumace atomic absorption spectrophotometer at a wavelength of 288.3 nm for lead heavy metal.

3 RESULTS

From the 270 cattle blood samples examined, amount 20 samples were found positive for lead heavy metal contamination. The average levels of the lead heavy metal in cattle blood (0.109 ± 0.080 ppm) did not exceed the maximum threshold level for consumption, namely

1.00 ppm (BSN, 2009). Meanwhile, the lead content in soil and drinking water were 0,239±0,136 ppm and 0.192±0.894 ppm. respectively (see ***Table. 1***).

Table 1. *The lead heavy metal content in the cattle blood, soil and drinking water.*

Regency	Positive Number	Content of lead heavy metal (ppm)		
		Cattle's blood	Soil	Drinking Water
Badung	4	0,322 0,024 0,225 0,062	0,415 0,415 0,324 0,168	0,350 0,365 0,305 0,154
Buleleng	3	0,181 0,143 0,042	0,664 0,286 0,192	0,363 0,272 0,145
Denpasar	5	0,242 0,141 0,062 0,087 0,072	0,286 0,226 0,188 0,098 0,184	0,205 0,221 0,154 0,090 0,165
Gianyar	2	0,122 0,065	0,283 0,142	0,166 0,122
Jembrana	2	0,084 0,092	0,114 0,106	0,102 0,144
Karangasem	1	0,086	0,129	0,122
Klungkung	1	0,095	0,186	0,124
Tabanan	2	0,014 0,024	0,190 0,181	0,132 0,142
	20	0,109±0,080 ppm	0,239±0,136 ppm	0.192±0.894 ppm

The research data show that there were variations in the lead levels contamination, both in the cattle blood, soil and drinking water, where the cattle were kept (***Table. 1***). The content of lead heavy metal contamination was higher in the soil (0.239 ± 0.136 ppm) and drinking water (0.192±0.894 ppm at the farm location than in cattle blood (0.109 ± 0.080 ppm). Regression test shows that lead heavy metal content in soil and drinking water is significantly ($p<0,05$) associated with lead content in cattle's blood (***Table. 2 and 3***).

Table 2. *Regression analysis of the lead content between cattle's blood within soil.*

Model	***Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Regression	*,033*	*1*	*,033*	*6,630*	*,019b*
Residual	*,089*	*18*	*,005*		
Total	*,122*	*19*			

a. Dependent Variable: soil

b. Predictors: (Constant), cattle

Table 3. *Regression Analysis of the lead content between cattle's blood within drinking water.*

Model	***Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Regression	*,050*	*1*	*,050*	*8,782*	*,008b*
Residual	*,006*	*18*	*,006*		
Total	*,056*	*19*			

a. Dependent Variable: water

b. Predictors: (Constant), cattle

In general, lead heavy metal contamination into the body of animals and humans is through the oral, respiratory, and skin routes, but most enter through the orally in the form of food and drinking water. The entry of particles through absorption in the intestine is a small particle. Not all the lead heavy metals which enter the body can stay in the body. About 5% of the amount swallowed will be absorbed by the digestive tract. Likewise, about 5% that is absorbed through inhalation will stay in the body [11]. The lead heavy metal contamination damages cells / tissues through oxidative stress mechanism [12]. The tissue most sensitive to heavy metal contamination is the liver [13]. Sources of lead heavy metal pollution can come from the soil and water environment [14]. Plants that grow in a polluted environment will also be polluted. If the plant is eaten by cattle, the cattle will be contaminated by lead heavy metal. This is evidenced in intensive farming of dairy cows; in fact, their blood is positive for lead heavy metal [15].

Regression analysis showed a relationship between levels of lead heavy metal in the cattle blood and levels in soil and drinking water at the farm site. This reinforces the notion that cattle can be a bio-indicator of pollution in an environment. It is reported that every animal has a sensitivity to heavy metal exposure, so it is called a bioindicator of the level of pollution in its environment. Several types of animals have been reported as bioindicators of environmental pollution, including buffalo [16], cattle, sheep, and camels [17, 18] and forest anoa [19]. The results showed that cattle can also be bioindicators of environmental for the lead pollution level.

4 CONCLUSIONS

The presence of lead heavy metal contamination in cow blood can be used as a bioindicator of lead heavy metal pollution in the soil and drinking water environment. Cows are very sensitive to the presence of environmental pollution around them, so that pollutants can immediately enter their blood circulation system.

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