DETECTION OF MERCURY IN BACKYARD PIGS' MEAT AND WATER SOURCE IN MINING IMPACT COMMUNITIES OF ARAROY, MASBATE

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ABSTRACT

This study determined the level of mercury (Hg) from the meat of backyard pigs raised in communities directly affected by the small-scale gold mining industries in Araroy, Masbate, as well as from the water sources used for raising the same animals. Two meat samples from newly butchered pigs were collected from each of the four impact communities. The water samples were obtained from Guinobatan River that runs along the impact communities, tap water from the faucet and stocked water from water trough of the pigs. All samples were analyzed using Atomic Absorption Spectrophotometry-Cold Vapor Technique. One meat sample and one water sample from the same community were positive for mercury at a level of <0.10 µg/g and 0.001 mg/l respectively. The traces of mercury detected in these samples were within the admissible concentration. Results are a significant indicator that the environment is contaminated with mercury and that mercury residue in pork and water may endanger food safety and cause serious public health hazard. There is a need therefore for strict imposition of proper waste disposal of mercury among small-scale gold mining firms.

Key words: backyard pigs, impact communities, mercury, small-scale gold mining, water source

INTRODUCTION

Backyard pig raising is an alternative source of livelihood in Araroy, a municipality of Masbate, Philippines, known for its large and small-scale gold mining firms. Many of these pigs raised are located in communities that surround the mining firms. These communities are called "impact communities" because of their proximity to the mining sites and are directly affected by their operations. They are also most likely to be affected by mercury (Hg), a toxic metal (Badis, 2014) highly used for extracting gold from its ores (Israel and Asirot, 2002). Small-scales gold miners have been labeled as notorious users of mercury (Leung and Lu, 2016). It has been observed that gold panners dispose of their waste openly to the river system that runs along the impact communities. Ingestion of these contaminants

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by animals causes deposition of residues in meat (Badis *et al*., 2014). Mercury contamination in pigs' meat may lead to the conclusion of environmental pollution affecting the animal's drinking water.

Since mercury is not a degradable material, it can be detrimental even at a low dose or concentration when ingested for a very long time because of its ability to accumulate in the human and animal body. This study is significant because bioaccumulation of mercury in humans through consumption of meat contaminated by it poses a health risk in consumers. In humans and in animals, toxicity related to mercury is associated with reproductive effects and neurotoxicity (Georgescu *et al*., 2011).

In this study, the concentration of mercury in meat and water samples was determined. The meat samples were taken from newly butchered pigs raised in the impact communities while the water samples were taken from different sources of pig's drinking water: the Guinobatan River, tap water from the faucet and stocked water from water troughs. The study aimed to verify the presence of mercury in meat and water samples in impact mining communities of Aroroy, Masbate.

MATERIALS AND METHODS

The study used a descriptive-cross sectional design to describe the mercury residue detected in meat and water samples. Four "impact communities" were assigned as Communities A, B, C and D. These communities were the most proximal among the eight villages that surround the mining areas in Aroroy, Masbate.

Two samples of meat were taken from newly butchered pigs raised from these impact communities for a total of eight samples. The meat samples were packed in sterile Ziploc bags, properly labeled, stored in cooler with ice to preserve its freshness and transported to the laboratory for analysis. Water samples were taken from the pig's corresponding water source. In Community A, water sample was taken from the faucet's tap water while in Community B the sample was taken from the tap water stocked in the cup drinker or drum. In Communities C and D the samples were taken from the Guinobatan River and tap water from the faucet, respectively. The water samples were placed in ordinary water bottles. Sampling and analysis were done from October to December 2015.

All specimens were analyzed for mercury residue using Atomic Absorption Spectrophotometry-Cold Vapor Technique. Data were analyzed via frequency count.

RESULTS AND DISCUSSION

In Table 1, one meat sample (1/8) from Community B or just 12.5% of the total samples collected revealed a trace of mercury at <0.10 μg/g. At the same time, a sample (1/4 or 25%) from a water trough in Community B was also positive for a trace of mercury at 0.001 mg/l. The concentrations were lower than the maximum admissible concentration established by the Codex Alimentarius Commission. However, the results indicate that the main source of mercury arises from contamination of water.

In the impact communities, pigs are raised tethered near the small-scale mining areas. Mercury is the main agent used to separate the gold from the mined ore employing the amalgamation method of processing (Israel and Asirot, 2002). One way in which the drinking water of these pigs gets contaminated with mercury is through smelting. During

Table 1. Mercury level in water sources and meat of backyard pigs raised in impact mining communities of Aroroy, Masbate.

Community	Mercury Level (mg/l) in Water Source	Mercury Level (µg/g) in Meat Sample
A	Negative	ND
B	Positive	<0.10 µg/g
C	Negative	ND
D	Negative	ND

Philippine National Standard for Drinking Water, DOH (DAO, 2007-2012)

Legend: Negative - mercury level in water is below the detection limit; <0.001 mg/l
Positive - trace of mercury detected in water; 0.001 mg/l
ND - none detected; no trace of mercury found in meat

the process of smelting gold, tiny dusts containing mercury are deposited on the roof or walls of the smelting area. These mercury particles are carried by the wind and may fall wherever around the area (Boulanger and Gorman, 2004). Another way is through puddles of waters that leak from the ball mills especially when it rains. In addition, small-scale mines within the impact communities are approximately 10 meters away from the Guinobatan River, the main river that runs along these villages. It is likely that gold sediments from these mines are washed up on the river system because of the apparent gold panning activity in the river. Thus, more mercury is introduced in the water to recover gold.

Rice *et al*. (2014) cited that mercury is ranked third by the US Government Agency for Toxic Substances and Disease Registry of the most toxic substances on earth that are released into the waterway and consumed via food and water. Since the pumping station of Aroroy water district lies along the Guinobatan River, there could be a possibility that this water, which could be contaminated with mercury, is distributed into the drinker of pigs. This is almost the same with a case reported by foreign study since 1995 with Diwalwal, Compostela Valley, the largest small-scale mining site in the Philippines, where a considerable amount of mercury loads in some sectors of Agusan River where Diwalwal drains (Israel and Asirot, 2002). In other countries like Kyrgyzstan, a river contaminated by mercury is the source of drinking water for cattle (UNEP, 2009). Mercury also pollutes mainly water resources in Ghana, Africa (Yeboah, 2008). Certainly, mercury released into the environment, like in the case of Aroroy, eventually end up in soils or surface waters (Solidum *et al*., 2013) and end up in potable waters consumed by both animals and humans.

Another common entrance of mercury is through the food chain via a process called methylation (US-EPA, 1997). The elemental and inorganic mercury discharged in the water may be methylated by microorganisms present in sediments of bodies of fresh and ocean water. This natural biomethylation reaction produces methylmercury (MeHg), the toxicologically most important organic form of mercury. It enters the biological system through the food chain and becomes concentrated in living organisms (Akagi *et al*., 2001) . In animals as well as humans, MeHg and its salts are readily absorbed in the gastrointestinal tract (>80%) and are widely distributed in all tissues especially the kidney (EFSA, 2008).

Mercury is harmful to an animal's health (Suttle, 2008). The pigs that drink water contaminated with mercury will accumulate it in their bodies. Mercury affects every system

system in the animal body (Bampidis *et al*., 2013) and may eventually cause teratogenicity and embryocidal tendencies in pregnant sows. On the other hand, mercury is also a known human toxicant (US-EPA, 1997). Being on top of the food chain, individuals who consume mercury tainted meat will also bioaccumulate it in their tissues. The number one repository of mercury exposure is the nervous system (Rice *et al*., 2014) with neurotoxicity as its sequelae (Klaassen, 2008).

The result of this study is in close correlation with the mining industries present in Aroroy, Masbate. The presence of mercury in pig's meat points out that mercury is an important environmental contaminant due to its industrial use. Anthropogenic sources such as mining have become significant contributors to the presence of mercury in water supplies and animal tissue. Pigs that are raised near small-scale mining firms are at risk of accumulating mercury in their tissues and may have harmful effects on their health. Pig raisers are also accountable to their husbandry practice of raising these pigs where extraction of gold using mercury is usually performed. Although the concentrations were lower than the maximum admissible amount established by the Codex Alimentarius Commission, low dose exposure should not be neglected due to the bioaccumulation nature of mercury and its threat to food safety and health of consumers. It is recommended that the local government unit of Aroroy should be strict in imposing environmental policies on mining firms. In addition, more samples and uniform sampling method should be done in future researches to establish the presence of mercury in livestock in the locality.

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