Mercury Contamination in Nam Son Landfill, Hanoi, Vietnam: Environmental and Human Health Risks

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ABSTRACT

Mercury is one of the top ten chemicals or groups of chemicals of major public health concern, its emissions pose a global environmental pollution problem. In the natural environment, Hg can participate in the biochemical cycle, it can be converted to methylmercury - the unique form of Hg by converting the original soil environment from aerobic to anaerobic and engaging with microorganisms. Hg cause problems such as kidney and nerve damage, sleep disturbances, hearing loss, impaired reproductive function, and heart issues. Hg is classified by the US Environmental Protection Agency (EPA) as a group D carcinogen, and methyl mercury is classified as a group C carcinogen. However, Hg is still used in the manufacture of skin care products and consumer goods such as thermometers, lamps, batteries, watches, switches. After these products are no longer in use, they still contain a certain amount of Hg and can disperse into the environment if not properly recovered.

Landfills are concerning due to pollution caused by the classification, collection, and treatment of waste, especially in developing countries like Vietnam. Landfills have the potential to contribute to Hg pollution, due to the burial of waste containing Hg. Thus, in this study, we investigated the potential risks of Hg to humans and the entire ecosystem using soil and rice samples sourced from paddy fields located near the Nam Son landfill area in Soc Son, Hanoi, Vietnam.

Specifically, Chapter 1 discuss about the general introduction and literature review. Chapter 2: In this study, we assessed the levels of Hg in the paddy soil around the Nam Son landfill, during both rainy (September 2021) and dry (January 2022) seasons.

The concentration of Hg was in the range of 20.5 to 79.7 μg/kg dry w.t. in Bac Son and Nam Son, and 16.6 μg/kg dry w.t. at a higher reference site. In most of the samples, the rainy season showed higher Hg concentrations than the dry season. Soil samples taken closer to the landfill exhibited higher levels of Hg contamination compared to those in more distant paddy areas, suggesting a decreasing trend of Hg concentration as one moves away from the pollution source. Additionally, Hg concentration was found to decrease vertically from the surface, with the higher value observed in the surface layer (0 – 5 cm), and the lower in the bottom layer (20 – 25 cm). The geo-accumulation index showed that all the sampling points were moderately to heavily polluted, indicating that Hg was lost from the waste source in the landfill. This study provides valuable insights into the spatial and vertical distribution of Hg pollution in the topsoil and highlights the importance of managing and assessing the risks of Hg-containing waste. The Hg concentrations in the paddy soil from Nam Son landfill were positively correlated with soil organic matter (SOM), but no correlated with pH.

Chapter 3: This study evaluated the mercury contamination in rice plants, which are typical foods cultivated in the Red River Delta. Mercury (Hg) accumulation in rice is a health concern due to the consumption of rice as the staple food. This study evaluated the mercury contamination in rice plants, which are typical foods cultivated in the Red River Delta. During the harvest season, rice samples were collected and separated into husk and brown rice, together with polished white rice and bran rice from mill shop. For brown rice, the Hg concentration ranges from 7.18 ± 0.73 to 16.32 ± 2.57 μg/kg. Additionally, brown rice samples near landfill or highway tend to have higher Hg concentrations than sites farther away. Hazard quotient (HQ) was used to measure the

health risk of Hg in this study. HQ values of male and female all were less than one, indicating that consuming rice from Nam Son and Bac Son might not cause potential human health risk of Hg exposure.

Chapter 4: This study investigated the hair Hg concentrations and assessed the Hg exposure through rice consumption for local residents around the Nam Son landfill area. Thus, 16 human hair samples, along with questionnaires, were collected to assess Hg exposure and human health risks to residents living near the Nam Son landfill. Additionally, the study aimed to investigate their exposure to Hg through rice consumption and significant predictors of hair Hg levels, such as age groups, smoking habits, occupation, through questionnaires. The results showed that the mean of Hg concentration in hair was 0.88 ± 0.05 mg/kg lower than the reference level (1.0 mg/kg) recommended by the United States Environmental Protection Agency (US EPA), indicating that residents in this area were exposed to low levels of Hg. There was no significant difference in the accumulation of Hg in hair between different age groups, smoking habits, and rice consumption. However, there was a significant difference between landfill workers and non-landfill workers, suggesting that landfill activities directly affect human mercury exposure.

Keywords: Vietnam, Nam Son landfill, mercury, soil, rice, hair, paddy field, HQ

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