Research Article

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Detection of lead and copper in hair samples and their impact on health of compost industry workers at Mehmood Booti Landfill Site Lahore, Pakistan

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Abstract | Management of industrial wastewater is a severe issue in developing countries such as Pakistan. Although solid waste materials from industrial effluents are discharged directly into sewerage systems, they are not easily carried off by water or airflows. Presence of toxic heavy metals in these waste materials is a major health concern. Present study was conducted to detect lead and copper in the hair samples from compost industry workers, Lahore Compost Private Limited, a Municipal Solid Waste recycling Company in Lahore, Pakistan. For this purpose, 75 hair samples from the workers at the Mehmood Booti Landfill Site were collected. General health assessment was done through survey and questionnaire. Analysis of lead and copper in hair samples was done by using atomic absorption spectrophotometer. Results revealed that the concentration of lead and cooper was significantly higher than the permissible limits. It was also observed that with the increase of age and experience of worker in compost industry, the lead and copper concentration in the hair samples of workers also increased.

Introduction

The high rate of population growth and urbanization in developing countries, coupled with paced economic growth, not only accelerates consumption rates but also results in massive generation of wastes (Ahmed *el al*., 2008). Composting is one of the latest and fast growing techniques used to reduce the amount of municipal solid waste going to landfills. Some biological and chemical contaminants may be added into composts. These contaminants may have adverse health effects. The amount and variety of

contaminants may vary in municipal wastes in different populations depending on area and environment. It may include heavy metals like copper (Cu), mercury (Hg) and lead (Pb). Compost workers may get affected by contaminations through hand to mouth contamination or ingestion of food grown in contaminated compost (Déportes el al., 1995).

Lead and copper are heavy metals which are toxic to humans. On-going exposure to even small amounts of lead may eventually result in harmful levels accumulated in the body. Once lead is absorbed into blood, it is either eliminated from body (mostly in urine) or builds up in organisms bones. It can remain stored in body for over 30 years (Barbosa el al., 2005). Copper is a part of normal human diet. According to World health organization (WHO), upper safe limit for copper ingestion is 2 mg/L of drinking water (World Health Organization, 1993). Health effects associated with exposure to high levels of lead and cooper include gastrointestinal distress, abdominal pain, nausea, vomiting, diarrhea, convulsions, coma or even death (Bergomi et al., 1989; Araya et al., 2001). Hair has been widely used as a biological material for the analysis of metal contents in an organism. Therefore, it is considered to provide information about the degree of exposure to environmental contaminants (Abbas and Cheema, 2014).

Solid waste composting is a new and growing activity in Pakistan. Several studies show that compost workers are at risk of lead and copper intake through dust and hand to mouth ingestion of food without hand washing prior to food intake. Workers are reported to have respiratory, gastrointestinal, skin symptoms and irritation in eyes; nose and throat. Aim of the present research work was to assess the prevalence of work related health problems among compost workers. Present studies were carried out to analyse

concentration of lead and copper (Cu) metal in hair of compost workers.

2. Materials and Methods

2.1. Sampling site
Present study was conducted to analyse the lead and cooper content in the hair of compost workers of Mehmood Booti Landfill Site, Lahore. It is located near Lahore Ring Road at latitude 31.6098, longitude 74.3867 and elevation 210 m (Figure 1). It is the oldest waste disposal site in Lahore. Mahmud Booti is one of the three main solid waste dumping sites of Lahore. The city's inhabitants from posh and clean areas and from the worn-out age-old neighbourhoods of the ancient Walled City area, produce approximately 3000 tons of waste per day. This represents only about 70% of the total garbage; whereas the remaining 30% is not even collected (Haydar et al., 2012).
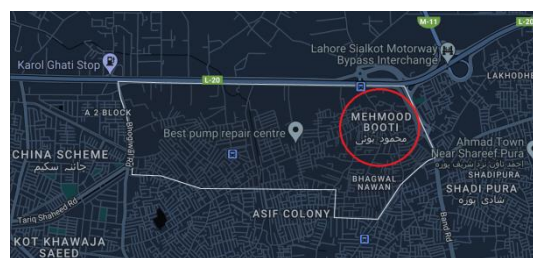

Figure 1: Mehmood Booti Landfill Site, Lahore.

2.2. Studied population
Present study included sample collection, detection of lead and cooper in hair samples of 75 compost workers. All the workers included in present study were male ranging from age sixteen to sixty years of age. All samples were collected according to standard protocols (Ciszewski el al., 1997). A written informed questionnaire was also administered to workers (16 – 60 years) to document their general habits and health status. Hair samples were obtained with written verbal consent. Questions were asked about the personal health information of workers,

dietary habits, availability of drinking water, and general habit i.e., smoking etc.

2.3. Sample collection and preparation

Hair samples were collected from the nape of the scalp by cutting 2mm from the scalp using a pair of sterilized stainless steel scissors washed with ethanol, a neutral solvent to remove external contamination, and sealed in plastic bags prior to analysis. The collected samples were taken to the Environmental Science Research Laboratory at LCWU Lahore for analysis.

Hair samples were cut into small pieces for easy digestion, washed with non-ionic detergent, soaked in deionized water, then soaked in acetone for 10 minutes to remove external contamination. All samples were then washed with deionized water and dried in oven at 110 °C for 1 hour and finally kept in desiccators. About 1.5 g of each hair sample was dried in oven in separate crucible for partial dryness. The dried hair samples were digested with 5 mL of mixture of concentrated nitric acid and perchloric acid (6:1), all samples were heated till complete evaporation to obtain water clear solution. Finally, these were diluted with distilled water up to 100 mL (Ciszewski *el al.*, 1997).

2.4. Sample analysis

Each solution was analysed by atomic absorption spectrometer model FS95 to estimate amount of lead and copper in it. About 1000 mg/L of standard solution of lead and copper were prepared according to procedure recommended by the manufacturer. About 5 mL of each sample was analysed at most suitable wavelength with minimum or no interference. After the completion of analysis for lead and copper concentration in hair sample was calculated, results were scrutinized and tabulated. Averages, percentages, range and standard deviations and standard error mean were calculated. All the results were analysed statistically using Minitab (statistical-software version).

3. Results

Current studies reveal that 37% of the workers under study were suffering from different diseases such as gastrointestinal aliments, muscular pain, abdominal pain, tuberculosis and diarrhea.

The analysis of hair samples for lead (Pb) concentration showed a significant high amount of lead in hair of workers. The concentration of lead in hair samples of workers was above the permissible limit 0.07 mg/L. The lead concentration in hair samples of workers ranges from 0.0417 to 2.497 mg/L with a mean concentration of 0.57862±1.005 mg/L (Figure 1).
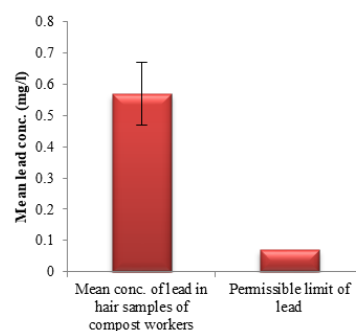

Figure 1: Comparison between mean concentrations of lead in hair samples of compost workers with permissible limit.

Similarly the analyses of hair samples of compost workers showed high concentration of copper (0.43±0.95 mg/L) in their hair samples which is higher than the permissible limit. Concentration of copper in their hair sample ranges from 0.01 – 1.0913 mg/L (Figure 2).
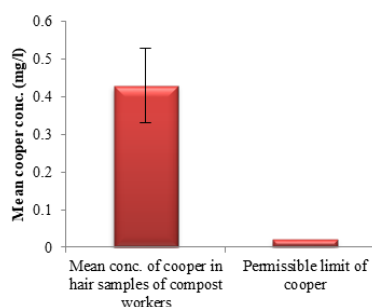
Figure 2: Comparison between mean concentrations of copper in hair samples of compost workers with permissible limit.

In order to find out relation of age with concentration of lead and copper, studies were carried out in which concentrations of lead and copper metals in hair samples of compost workers of different age groups were analysed. It was observed that a higher concentration was found in older age group (0.68±0.0.245mg/L) and a lower lead concentration was found in hair samples of young age group (Figure 3). Similarly, it was observed that the copper concentration in all hair samples of old age workers was greater than the younger workers (Figure 4).
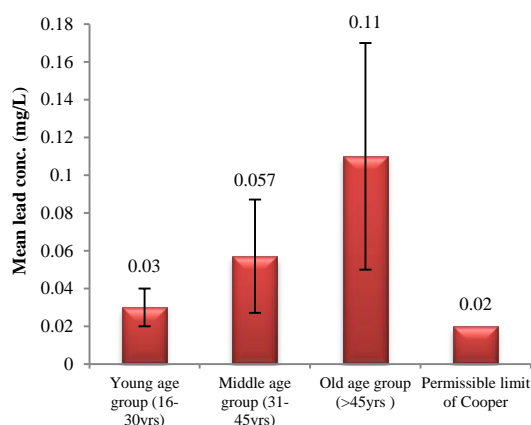

Figure 3: Comparison between average concentrations of lead in young, middle and old age group workers with permissible limit of lead.
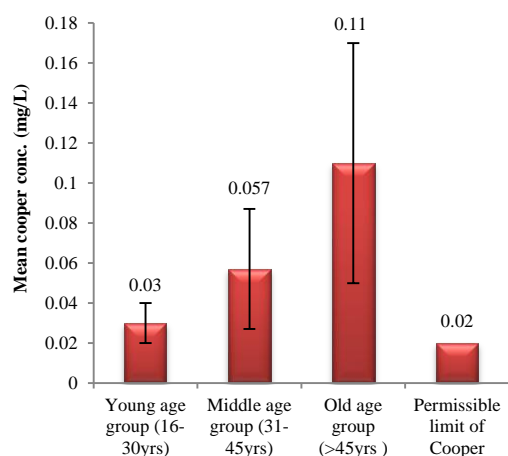

Figure 4: Comparison between average concentrations of copper in young, middle and old age group workers with permissible limit of copper.

4. Discussion

In present study a detailed survey of a landfill site was done for the purpose of health assessment of compost workers and collection of hair samples to detect the level of lead and cooper in the hair of workers. During studies, general health of workers was also taken under consideration. It was found that general health and working environment of compost workers was not satisfactory. Poverty, unhygienic working environment, and lack of access to clean food and drinking water are major causes of illness and disabilities in people doing sanitary jobs.

During present studies, 37% of the workers were suffering from various gastrointestinal diseases. Their poor health condition was related to poor economic status, no access to health resources, nutritional deficiencies and unhygienic working environment. Exposure to high levels of lead and copper can cause serious health effects including vomiting, diarrhea, convulsions, coma or even death (Araya *et al*., 2001).

The lead concentration in hair samples of workers had a mean concentration of 0.57862±1.005 mg/L, this is higher than the permissible level of lead in hair (0.07mg/l). Similarly, the copper concentration in hair samples of workers had a mean concentration of 0.43±0.95 mg/L which is above the permissible levels (0.02 mg/L). High level of lead in compost workers may be due to direct exposure. Similar results were reported by Hertz-Picciotto and Croft, (1993) where it was concluded that in human beings the pathway of lead ingestion is through direct occupational exposure, water intake as

well as ingestion of contaminated food. Another study showed a strong relationship of time exposure with the average concentrations of lead in young, middle and old age group workers which clearly showed that as the exposure time increases the concentration of lead also increases (Nriagu, 1996). Due to longer time periods of exposure affected population were exposed to more lead contamination and thus had higher concentrations of heavy metals.

The higher copper metal concentration in hair samples of old age workers as compared to the younger workers was probably due to more exposure time of workers to the environment. Exposure time to copper contaminating environment is another factor that can affect amount of copper in hair sample of compost workers. People who are exposed to such environment for long time have more copper content in their bodies and hair samples as well. However, further studies are needed to establish a strong relation between exposure time and amount of copper in compost workers. However, current work is related to studies carried out in compost industry in Nigeria. It was shown there that amount of iron, cadmium and copper in old age people was greater than those who were relatively younger workers (Abdulrahman *et al*., 2012).

Improper working environment and less use of personal protection equipment (PPE) may also lead to more exposure to copper. The situation demands urgent mitigation measures such as copper testing compulsory, establishing a guideline value for copper. Short term and long-term mitigation policy are required for compulsory screening for diseases due to heavy metal poisoning in government hospitals, especially in those that are located near the industrial areas.

5. Conclusions

It was deduced that compost at Mehmood Booti Landfill Site Lahore contained high amount of heavy metals lead and copper. The compost workers had more than normal permissible limits of lead and copper content accumulated in their hairs, this exposure was due to their unhygienic and unclean environment. Presence of these metals in higher than normal levels caused serious health hazards. Working environment, exposure time and age of worker all affected the amount of lead and copper accumulated in bodies and hair of compost workers. It is strongly recommended that short term and long term environmental safety measures are needed to provide health safety to compost workers.

6. Acknowledgments

7. Author's Contribution

All authors contributed equally.

8. Conflict of Interest

There is no conflict of interest.

9. Novelty Statement

In Pakistan, waste management industry is rapidly growing to minimize waste. For that, different techniques are being used like land filling, incineration, recycling, and composting etc. However, there is a need to pay heed to health aspect of compost workers. Unhygienic food and water and contaminated water are reasons which may cause hazardous effects to workers community of compost industry. High amount of trace metals like copper enters in bodies of workers. It may cause bad health effects.

10. References

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