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EVALUATION OF HEAVY METALS IN SOLID BIO-MEDICAL WASTE FROM SELECTED HOSPITALS IN PATIALA, PUNJAB, INDIA

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Abstract: Bio-Medical Waste (BMW) consists of solids, liquids, sharps and laboratory waste. Disposal of BMW in a scientific manner minimizes the adverse impact on health workers and environment. Improper disposal leads to a higher degree of environmental pollution apart from posing serious public health risks. Heavy metals migration is a serious environmental problem. The retention and migration of heavy metals are highly dependent on soil composition, pH, the degree of saturation and time duration. The heavy metals are considered to be toxic to the environment and human health when their concentration exceeds a standard value. Leaching of the heavy metals may lead to contamination of the soil and water bodies. Heavy metals being absorbed by plants enter into the food chain and cause physiological and neuropsychological hazards in human beings as they play an important role in the growth process and metabolism of the human body. Therefore, the high level of heavy metals in the solid BMW should be properly disposed of at landfill site. The present investigation has been carried out to evaluate the relative content of heavy metals in bio-degradable solid BMW from January 2016 to December 2016 in three Private and four Government hospitals of Patiala in the state of Punjab in India. The heavy metals studied are copper (Cu), zinc (Zn), nickel (Ni) and cadmium (Cd).

Keywords: Bio-medical waste; Disposal; Health; Hospital; Leaching; Segregation; Treatment.

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INTRODUCTION

Bio-Medical Waste (BMW) originating from hospitals and clinics including veterinary health facilities, research laboratories, etc. during diagnosis, treatment or immunization of humans or animals or research related activities, has direct environmental consequences. BMW quantity is increasing at an alarming rate in India due to rapid urbanization and a high population growth. Hospital waste consists mainly of three types of wastes: medical waste, infectious waste and domestic waste. WHO (2004) reported that 85% of hospital waste are actually non-hazardous, around 10% are infectious and around 5% are non-infectious but hazardous wastes. The waste generated during the health-care activities carried a higher potential for infection than any other type of wastes (Manohar *et al.,* 1998; Chauhan *et al.,* 2002; Joe Joseph and Krishnan, 2004. Studies carried out in India showed that awareness and practices on BMW management among health-care personnel is far below the acceptable level (Sharma, 2010; Bansal *et al.,* 2011; Mathur *et al.,* 2011; Saini *et al.,* 2012). No appropriate strategy exists for proper management of BMW. We all must remember that it is our moral duty to take care of the waste so that we all are protected from the risks of hazards of BMW. The proper handling BMW is of prime importance and therefore, health-care institutions must develop clear plan and policies for the management of BMW. BMW is required to be treated in a special and scientific way. The proper segregation, collection, identification and disposal of hospital waste will reduce the volume of infectious wastes and consequently the cost of treatment. There is plenty of scope for research in this field. The hazardous BMW contains toxic chemical and infectious agents. As most of the heavy metals are persistent, probably lasting for centuries, they will sooner or later threaten the water table and water bodies where their removal would be near impossible and they are known to have high leachability (British Society of Ecological Medicine, 2008). Vincent et al. (2016) made a comparative study of heavy metal contamination at common waste treatment and disposal sites of BMW in Mumbai, Maharashtra. They examined that heavy concentration of heavy metals in the medical waste can pose serious threat to the environment and multiple organ damage in humans. Certain heavy metals can affect the reproductive health of the animals (Code and Christen, 1999). The present study has been carried out in three Private and four Government hospitals of Patiala in the state of Punjab in India.

EPERIMENTAL

The present study was carried out from January 2016 to December 2016 in three Private and four Government hospitals of Patiala in the state of Punjab in India. The select hospitals for study are Amar Hospital, Bank Colony (H1); Columbia Asia Hospital, Bhupindra Road (H2); Sadbhavna Hospital, Charan Bagh (H3); Rajindra Medical College and Hospital, Sangrur Road (H4); Mata Kaushalaya Hospital, Lohori Gate (H5); T.B. and Chest Diseases Hospital, Sheran Wala Gate (H6) and two Community Health Centers, Tripuri and Model Town (H7). The relative content of heavy metals i.e. copper (Cu), zinc (Zn), nickel (Ni) and cadmium (Cd) has been estimated in the bio-degradable BMW by standard methods using Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

The present study has been carried out to evaluate the monthly variation of the content of copper (Cu), zinc (Zn), nickel (Ni) and cadmium (Cd) in the bio-degradable solid BMW in 3 Private and 4 Government hospitals in the city of Patiala.

(i) Copper (Cu)

The copper content of the solid BMW samples are given in Table 1. The monthly average values and ranges of copper content for each sampling sites are shown in Figure 1. Under experimental conditions, the copper content of the samples were found to be ranging from 2.12 mg/kg – 14.01 mg/kg with an average of 6.92 mg/kg at H1 site; 1.74 mg/kg –12.32 mg/kg with an average of 6.27 mg/kg at H2 site; 1.93mg/kg –12.18 mg/kg with an average of 6.42 mg/kg at H3 site; 2.72 mg/kg –12.20 mg/kg with an average of 6.38 mg/kg at H4 site; 1.68 mg/kg –15.38 mg/kg with an average of 6.04 mg/kg at H5 site; 3.16 mg/kg –13.54 mg/kg with an average of 7.70 mg/kg at H6 site, and 2.74 mg/kg –11.54 mg/kg with an average of 6.60 mg/kg at H7 site. Copper is generally regarded as harmless metal. However, liver damage may occur if high concentration of copper is exposed to the body for a long time (Tambekar and Kale, 2005). Copper is essential for the formation of enzyme in human beings. Copper toxicity in human beings includes blue green diarrhoea stool and saliva as well as abnormalities of kidney functions (Sharma and Agrawal, 2005). Copper can affect the photosynthetic functions of higher plants.

(ii) Zinc (Zn)

The zinc content of the solid BMW samples is given in Table 2. The monthly average values and ranges of zinc content for each sampling sites are shown in Figure 2. Under experimental conditions, the zinc content of the samples were found to be ranging from 3.46 mg/kg – 18.28 mg/kg with an average of 9.35 mg/kg at H1 site; 3.84 mg/kg –19.18 mg/kg with an average of 9.69 mg/kg at H2 site; 4.12 mg/kg –16.14 mg/kg with an average of 8.06 mg/kg at H3 site; 4.30 mg/kg –14.18 mg/kg with an average of 8.99 mg/kg at H4 site; 5.28 mg/kg –15.76 mg/kg with an average of 10.76 mg/kg at H5 site; 3.16 mg/kg –18.42 mg/kg with an average of 10.27 mg/kg at H6 site, and 3.16 mg/kg –14.86 mg/kg with an average of 7.92 mg/kg at H7 site. Zinc plays in important role in the growth process and metabolism of human beings. However, toxicity may result if zinc is in excessive concentration (Korolewicz *et al.,* 2001). Acute zinc toxicity in human beings includes vomiting, dehydration, lethargy, abdominal pain, nausea, lack of muscular co-ordination and renal failure. Zinc is an essential micronutrient that affects several metabolic processes of plants (Cakmak and Marschner, 1993).

(iii) Nickel (Ni)

The nickel content of the solid BMW samples are given in Table 3. The monthly average values and ranges of nickel content for each sampling sites are shown in Figure 3. Under experimental conditions, the nickel content of the samples were found to be ranging from 1.12 mg/kg – 12.18 mg/kg with an average of 6.34 mg/kg at H1 site; 1.88 mg/kg –12.81 mg/kg with an average of 7.56 mg/kg at H2 site; 3.54 mg/kg –8.84 mg/kg with an average of 6.71 mg/kg at H3 site; 1.84 mg/kg –12.74 mg/kg with an average of 8.49 mg/kg at H4 site; 0.88 mg/kg –11.24 mg/kg with an average of 5.82 mg/kg at H5 site; 0.88 mg/kg –14.22 mg/kg with an average of 7.31 mg/kg at H6 site, and 4.96mg/kg –10.63 mg/kg with an average of 7.73 mg/kg at H7 site. Although Ni is an essential element, but in high concentration it is not desirable because of its toxic effects (Sharma and Agrawal, 2005). Nickel toxicity causes dermatitis, respiratory tract irritation and asthma in humans. Nickel is a component of the enzyme urease and is essential for metabolic functioning and good health of man and animals (Tambekar and Kale, 2005). Nickel can reduce the photosynthetic activity of plants and can affect physiological processes.

(iv) Cadmium (Cd)

The cadmium content of the solid BMW samples is given in Table 4. The monthly average values and ranges of cadmium content for each sampling sites are shown in Figure 4. Under experimental conditions, the cadmium content of the samples were found to be ranging from 0.12 mg/kg – 1.28 mg/kg with an average of 0.83 mg/kg at H1 site; 0.12 mg/kg – 1.38 mg/kg with an average of 0.70 mg/kg at H2 site; 0.08 mg/kg –1.36 mg/kg with an average of 0.45 mg/kg at H3 site; 0.14 mg/kg – 0.98 mg/kg with an average of 0.51 mg/kg at H4 site; 0.18 mg/kg –1.12 mg/kg with an average of 0.55 mg/kg at H5 site; 0.08mg/kg – 1.26 mg/kg with an average of 0.68 mg/kg at H6 site, and 0.15 mg/kg –1.23 mg/kg with an average of 0.69 mg/kg at H7 site. Cadmium accumulates primarily in the kidneys, and its biological half-life in humans is 10–35 years (WHO, 2008). Its accumulation may lead to renal tubular dysfunction, which results in increased excretion of low molecular weight proteins in the urine which is generally irreversible (WHO, 2011). Health hazards related to Cd contamination in humans are emphysema, nausea, vomiting, diarrhoea, headache, salivation and renal death. Cd also increases blood pressure (Rajvaidya and Markandey, 2005). Cd is of particular concern in plants since it accumulates in leaves at very high levels. It may affect animal feeding on crops grown on solid BMW treated soil.

Table 1. Variation of copper (Cu) for solid BMW (mg/kg)

Sampling months	Sampling sites						
	H1	H2	H3	H4	H5	H6	H7
January	2.12	1.74	1.93	6.42	2.42	8.74	2.74
February	8.32	3.94	6.72	2.90	2.84	4.32	4.84
March	12.32	8.84	9.14	6.72	4.34	6.54	3.43
April	7.54	12.32	11.10	8.90	7.54	8.94	7.58
May	6.56	4.67	4.94	6.32	2.94	3.16	3.26
June	8.10	7.32	4.70	12.20	5.42	3.82	9.16
July	7.48	1.96	2.84	2.72	11.52	10.84	3.52
August	2.78	3.82	5.32	6.54	15.38	13.54	11.54
September	8.16	8.18	12.18	11.32	10.25	11.54	5.26

October	14.01	12.32	7.88	6.82	5.40	6.88	10.92
November	3.52	8.22	6.72	2.96	2.70	7.92	8.10
December	2.14	1.86	3.56	2.77	1.68	6.14	8.90
Mean	6.92	6.27	6.42	6.38	6.04	7.70	6.60

Table 2. Variation of zinc (Zn) for solid BMW (mg/kg)

Sampling months/Sites	H1	H2	H3	H4	H5	H6	H7
January	3.46	4.56	7.48	8.56	10.94	5.84	4.70
February	3.46	4.44	5.20	4.30	9.40	3.38	3.86
March	7.14	5.88	8.14	12.32	10.40	14.38	3.16
April	7.24	3.84	4.14	3.38	12.14	4.66	3.86
May	9.70	14.12	5.80	14.18	10.72	18.42	11.62
June	18.18	16.14	9.10	3.38	10.72	11.64	14.80
July	5.72	3.38	4.12	6.84	5.28	8.86	6.14
August	9.88	10.54	10.62	8.14	6.62	8.14	6.74
September	7.25	19.18	16.14	9.58	14.28	3.16	5.79
October	18.12	16.28	11.62	10.58	15.62	16.12	4.66
November	3.82	5.80	6.12	14.14	7.28	9.46	14.85
December	18.28	12.16	8.28	12.42	15.76	19.12	14.86
Mean	9.35	9.69	8.06	8.99	10.76	10.27	7.92

Table 3. Variation of nickel (Ni) for solid BMW (mg/kg)

Sampling months/Sites	H1	H2	H3	H4	H5	H6	H7
January	1.92	7.58	4.98	9.32	0.88	4.60	9.88
February	4.80	7.62	8.84	8.22	1.56	0.88	8.24
March	7.18	8.72	8.82	4.40	5.66	6.16	4.96
April	6.22	4.18	8.60	1.84	3.58	5.92	8.12
May	6.16	10.12	8.90	12.12	10.18	2.96	5.32
June	8.52	9.72	7.80	12.74	11.24	14.22	7.56
July	9.72	12.81	8.26	8.84	7.26	12.72	6.06
August	1.12	5.32	4.66	8.96	7.92	12.32	10.63
September	1.98	7.86	3.89	12.21	10.19	10.12	8.14
October	4.18	5.12	4.18	8.82	1.82	8.58	5.12
November	12.10	1.88	8.09	7.34	7.62	1.32	8.88
December	12.18	9.76	3.54	7.12	1.92	7.94	9.80
Mean	6.34	7.56	6.71	8.49	5.82	7.31	7.73

Table 4. Variation of cadmium (Cd) for solid BMW (mg/kg)

Sampling months	Sampling sites						
	H1	H2	H3	H4	H5	H6	H7
January	0.84	1.28	1.36	0.40	0.28	1.12	0.22
February	1.14	0.26	0.08	0.39	0.37	0.21	0.84
March	1.10	1.28	0.18	0.40	0.18	0.37	1.14
April	0.40	0.38	0.27	0.68	0.74	0.08	0.38

May	1.28	1.38	0.80	0.74	0.56	0.98	1.10
June	0.31	0.37	0.41	0.42	0.36	0.38	0.30
July	0.89	0.12	0.34	0.88	1.12	1.26	1.23
August	1.28	0.48	0.11	0.29	0.33	0.74	0.83
September	0.56	0.48	0.56	0.36	0.86	0.88	0.74
October	1.12	1.36	0.86	0.98	0.34	0.48	0.56
November	0.86	0.63	0.24	0.45	0.59	0.71	0.82
December	0.12	0.37	0.17	0.14	0.86	0.92	0.15
Mean	0.83	0.70	0.45	0.51	0.55	0.68	0.69

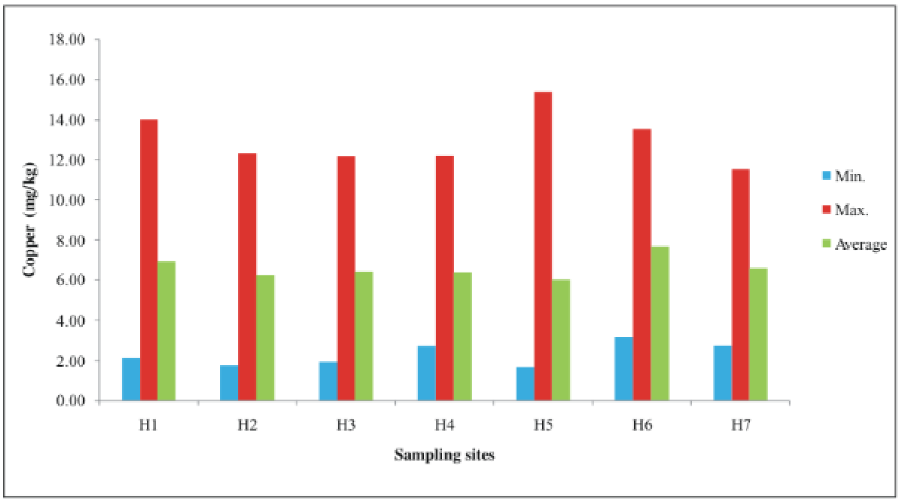

Figure 1. All monthly average values of copper content for solid BMW samples

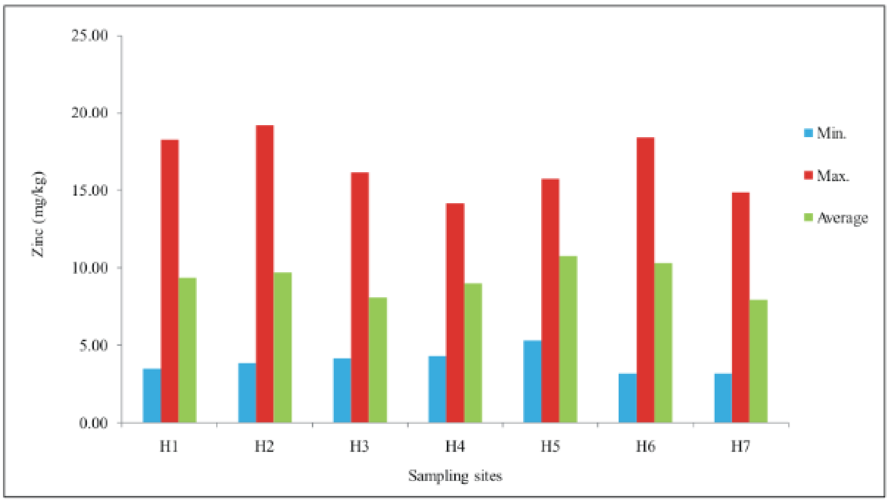

Figure 2. All monthly average values of zinc content for solid BMW samples

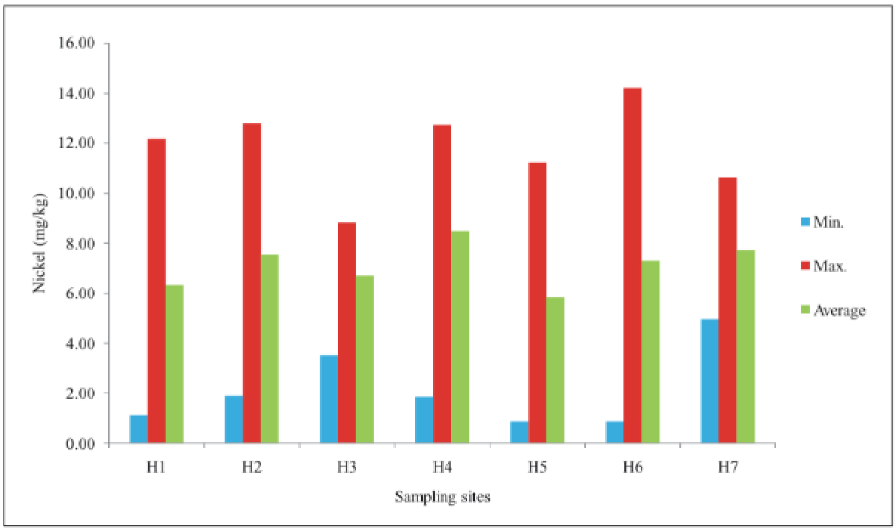

Figure 3. All monthly average values of nickel content for Solid BMW samples

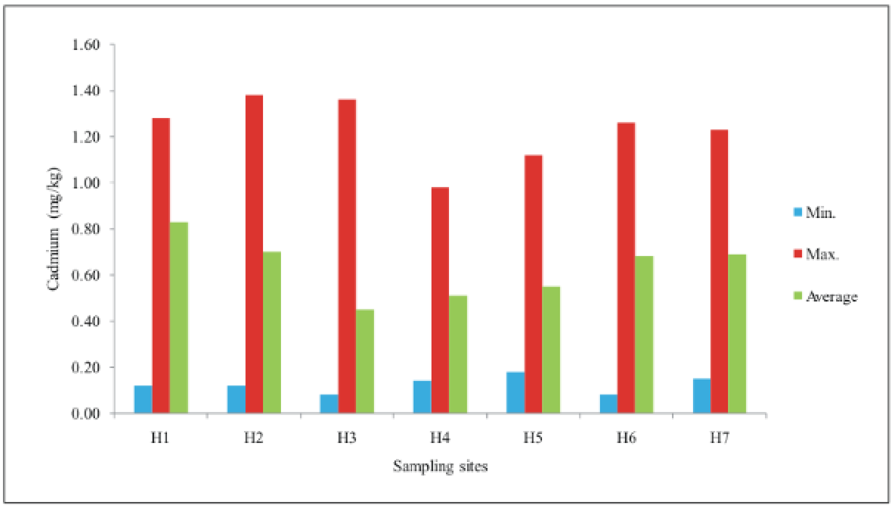

Figure 4. All monthly average values of cadmium content for solid BMW Samples

CONCLUSION

Heavy metals studied in the present investigation depicted an average high range of values than the permissible limits for all the sampling sites, indicating the improper handling of BMW at the site of generation. Effect of heavy metals contaminants on the environment depends on the metals availability and mobility in the soil and also on the soil composition and pH. Higher concentration of heavy metals in the BMW can pose serious threat to the environment and can lead to liver failure, gastrointestinal problems, kidney damage, hypertension and problems of reproductive system in the human body. BMW is required to be properly segregated at source. It is recommended that a safe and reliable method for handling BMW is essential. The best available technology for the treatment of BMW is incineration. The incineration process destroys pathogens and reduces the waste volume by 90% and weight by 75%. It is recommended that a safe and reliable method for handling BMW is essential.

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