Contamination by Persistent Organic Pollutants in Soils, Bovine Milk, and Human Breast Milk Collected from the Dumping Site of Municipal Wastes in India

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Introduction

Persistent organic pollutants (POPs) such as polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs), biphenyls (PCBs) and organochlorine insecticides are lipophilic stable contaminants of great concern with regard to their toxic effects on humans and wildlife. In developed countries, residue levels of these contaminants in various environmental media and biota generally decreased in recent decades (*1, 2*). In Asian developing countries, however, only very few studies reported the contamination status of these chemicals, especially dioxins and related compounds.

Asian developing countries have large open dumping sites of municipal wastes in the suburbs of major cities. Variety of municipal wastes have been dumped daily and continuously burned under low temperature by spontaneous combustion or intentional incineration. It is anticipated that dioxins and related compounds have been secondarily formed by combustion of municipal wastes, polluting the surrounding environment and hence exposing the residents and livestock around the dumping sites to these contaminants.

The present study attempted to elucidate the contamination status of POPs in soils, bovine milk, and human breast milk collected from the dumping site of municipal wastes in Chennai, India.

Materials and Methods

Soil samples (*n*=13) were collected in the Perungudi municipal dumping site located in the suburbs of Chennai city, India during August, 2000. Samples (*n*=5) were also collected in area around the dumping site (within 5km). Analysis of dioxins and related compounds in soils was conducted using the method reported previously (*3*).

Human breast milk samples (*n*=11) were collected from the mothers around the dumping site in August, 2000. In addition, samples (*n*=8) were collected from reference sites, which are located

about 10 km far from the dumping site. Breast milk samples were stored at –20 °C until analysis. Analysis of POPs, PCDDs, PCDFs, PCBs, DDTs, HCHs, HCB and chlordane compounds (CHLs), in human breast milk was conducted using the method reported previously (*4*).

Buffalo (*n*=3) and cow milk (*n*=2) samples were also collected in and around the dumping site in India during August, 2000. In addition, samples (buffalo: *n*=2, cow: *n*=3) were collected from reference sites, which are located about 10 km far from dumping sites. Bovine milk samples were stored at –20 °C until analysis. Internal standards were spiked, then bovine milk was added to separating funnel containing saturated sodium oxalate, ethanol, diethyl ether and hexane, and extracted twice. Cleanup and separation processes were followed by the method described previously (*4*). Identification and quantification of PCDDs, PCDFs, non- and mono-*ortho* coplanar PCBs was performed using HRGC-HRMS. Quantification of total PCBs, DDTs, HCHs, HCB, CHLs was performed using GC-ECD. TEQs were calculated using WHO-TEFs (*5*).

Results and Discussion

Dioxins and related compounds were detected in all the soil samples analyzed in this study (Table 1). Concentrations of dioxins and related compounds in soils from the dumping site were significantly higher than those from surrounding area ($p<0.01$), indicating that dioxins and related compounds have been secondarily formed by combustion of municipal wastes in the dumping site and coplanar PCBs might have been leached out from dumped electric apparatus.

Table 1. Mean and range concentrations (pg/g dry wt.) of dioxins and related compou in soils collected from the dumping site and its surrounding points in India

	Dumping site (n =13)	**Surrounding area** (n =5)
PCDDs	**5900** (1500-29000)	**26** (15-64)
PCDFs	**1400** (410-5500)	**6.2** (2.3-15)
non-*ortho* PCBs	**570** (350-1100)	**1.8** (1.2-2.6)
mono-*ortho* PCBs	**6100** (1300-20000)	**26** (12-52)
TEQs	**52** (13-210)	**0.25** (0.14-0.37)

POPs were detected in all the samples of human breast milk analyzed. Concentrations of dioxins and related compounds, PCBs, and CHLs in human breast milk from the dumping site were significantly higher than those from the reference site (Fig. 1). This result indicates that significant pollution sources of dioxins and related compounds, PCBs, and CHLs are present in the dumping site and residents around there have been exposed to relatively high levels of these contaminants. When the relationship between concentrations of POPs in human breast milk and the number of children were examined, levels of these contaminants were found to decrease with increase in the number of children. This result suggests that first infants have been exposed to higher levels of POPs from breast milk and might be at higher risk from these contaminants.

POPs were also detected in all the samples of bovine milk analyzed (Table 2). When the residue levels of POPs in bovine milk collected from the dumping and reference sites were examined, levels of dioxins and related compounds, PCBs, and CHLs in buffalo milk from the dumping site were

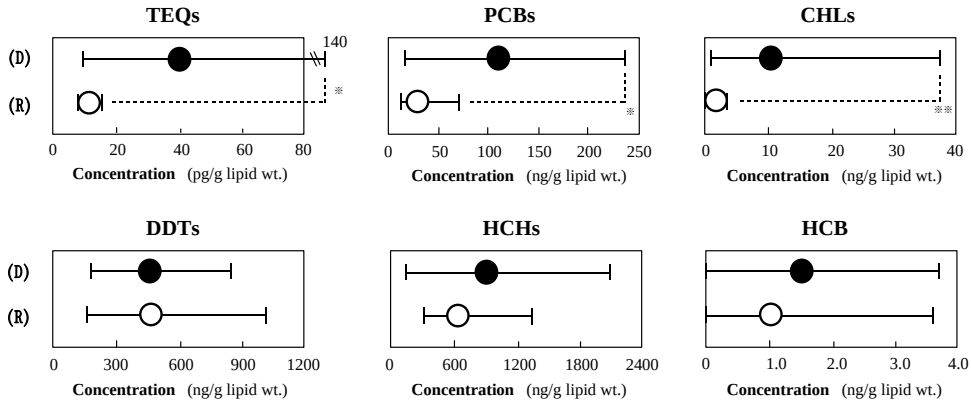


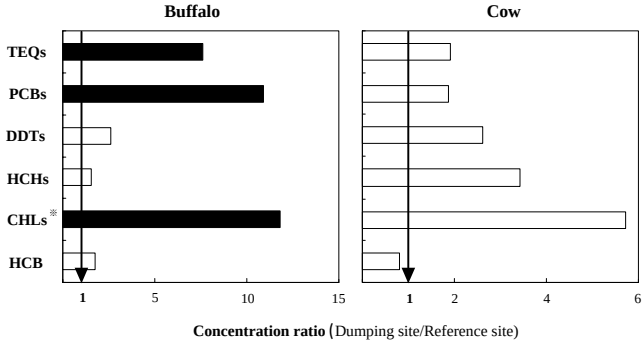
Fig. 1. Comparison of POPs in human breast milk collected from the dumping and reference sites in India.

apparently higher than those from the reference site (Fig. 2). In India, buffaloes are generally reared near to the waste dumping site and mainly feed dumped leftovers, while cows are reared around the dumping site and feed in pastures. This might lead to greater intake of dioxins and related compounds, PCBs, and CHLs by buffaloes than cows. In addition, the residents around the dumping site consume milk from these bovines, and therefore the trend of dioxins and related compounds, PCBs and

Table 2. Mean and range concentrations of POPs in bovine milk collected from the dumping and reference sites in India

	Dumping site		Reference site	
	Buffalo (n =3)	Cow (n =2)	Buffalo (n =2)	Cow (n =3)
PCDDs [a]	**15** (8.7-24)	**7.3** (7.0-7.7)	**4.7** (3.8-4.7)	**8.2** (2.2-12)
PCDFs [a]	**9.8** (6.6-15)	**5.8** (5.7-5.8)	**2.4** (2.0-2.8)	**3.0** (1.2-4.0)
non-ortho PCBs [a]	**87** (58-120)	**46** (44-49)	**11** (9.9-12)	**30** (10-47)
mono-ortho PCBs [a]	**8800** (5500-11000)	**2300** (2200-2400)	**750** (500-1000)	**3600** (410-5600)
TEQs [a]	**16** (12-24)	**7.3** (7.1-7.4)	**2.1** (1.7-2.4)	**3.8** (1.2-5.4)
PCBs [b]	**24** (7.2-55)	**6.0** (5.8-6.1)	**2.2** (1.4-3.5)	**3.2** (1.0-6.2)
DDTs [b]	**71** (39-130)	**55** (52-58)	**27** (12-36)	**21** (13-36)
HCHs [b]	**110** (36-260)	**130** (130-130)	**70** (26-130)	**38** (32-44)
CHLs [b]	**1.3** (0.37-2.6)	**0.63** (0.54-0.63)	**<0.11**	**<0.11**
HCB [b]	**0.93** (0.60-1.3)	**0.55** (0.54-0.55)	**0.54** (0.41-0.70)	**0.68** (0.38-1.0)

[a] pg/g lipid wt., [b] ng/g lipid wt.



※ The detection limit value was used in bovine milk from the reference site.

Fig. 2. Concentration ratio of POPs in bovine milk from the dumping site to those from the reference site.

CHLs observed in human breast milk was identical with that in bovine milk described above,

suggesting that bovine milk is a potential source of these contaminants to the residents around the dumping site in India. Assuming that an adult whose weight is 60 kg drink 176g of buffalo or cow milk per day (*6*), the daily intake of dioxins and related compounds from bovine milk in the dumping site ranged from 1 to 4 pg TEQs/kg/day of TDI proposed by WHO (*7*). The value in one buffalo milk sample exceeded TDI. This result implies that the residents around the dumping site might be at greater risk of contamination by dioxins and related compounds via bovine milk.

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