CONTAMINATION PROFILES OF UNEP POP'S AND PBDEs IN BROWN RAT COLLECTED FROM URBAN AND RURAL REGIONS OF JAPAN

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Introduction

Accumulation profiles of UNEP's POPs and polybrominated diphenyl ethers (PBDEs) considered to important due to their, long range atmospheric transport, persistence in nature, bioaccumulation potential and adverse health effects in wildlife and humans. Brown rat (BR) inhabits not only near human environment but also distributed worldwide. Especially, BR feeds on human waste and shelter in and around human environment and thus exposure of toxic contaminants in this animal considered to similar with those in humans. In our earlier study[1,2] we report elevated accumulation toxic contaminants in birds in Japan. Besides were also reports POPs and PBDEs in mixed BR liver extracts from urban region and consequent testosterone suppression[3]. In this study, we analyzed individual liver samples collected from urban and rural regions, waste dumping or land fill site and isolated remote island from Japan. For comparison purpose laboratory Wistar rats (WR) were used as control.

Materials and Methods

Norway or Brown rat "BR" (*Rattus norvegicus*) is considered to human indicators. Consequently, in this study, BR (several individuals in each location) was collected and their age and sex was determined. All the sampling details and some bio-metric data are presented elsewhere[3]. For comparison, 3 laboratory raised Wistar rat (WR) used as control that analyzed individually. For chemical analysis, liver was homogenized with Na_2SO_4 spiked with internal standards such as $^{13}C_{6-12}$-labeled OCPs, $^{13}C_{12}$- PCDDs, $^{13}C_{12}$-PCDFs, $^{13}C_{12}$-PCBs and $^{13}C_{12}$-PBDEs and Soxhlet extracted with dichloromethane (DCM) for 16-h. The details of sample clean were described in our previous reports[3-4]. The identification and quantification was performed using high resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS)[3-6]. Two methods blank samples were also analyzed. The blank doesn't contain quantifying amount of any target contaminants. Eventually, testosterone suppression experiment was determined by gene chip method. That proposed to present as separate short paper in dioxin 2005 meeting.

Table 1. Concentrations (pg/g lipid) of organochlorine pesticides and PBDEs in Brown and Wistar rats.

Rat	Wistar Rat	Brown Rat					
Sample Name	Lab. Control	Teuri-Is-Hk	Landfill-Sp	Tokyo-Snj	Tokyo-Ikb	Osaka-Umd	Osaka-Nnb
	n=3	n=1	n=3	n=3	n=3	n=3	n=3
HCHs	4,000	10,000	51,000	27,000	27,000	6,700	35,000
HCB	4,700	10,000	43,000	640,000	27,000	6,200	20,000
Cyclodienes	1,300	3,300	11,000	1,300	14,000	7,700	4,600
Chlordanes	4,000	30,000	63,000	70,000	52,000	10,000	25,000
DDTs	4,000	35,000	1,500,000	3,400,000	210,000	25,000	320,000
Total OCPs	18,000	88,000	1,700,000	4,100,000	330,000	56,000	400,000
Total PCBs	16,000	88,000	1,700,000	7,200,000	420,000	130,000	450,000

Detection limit 10 pg/g; The values rounded.

Results and Discussion

Mean concentrations of organochlorine pesticides (OCPs) are presented in Table 1. In BR, contamination of OCPs was in the order of DDTs followed by chlordanes, HCB, HCHs and cyclodienes. Particularly, BR from Tokyo-Snj contained maximum total OCPs concentrations followed by Landfill-Sp. Minimum concentrations of OCPs in control WR probably contamination of the laboratory fed diet. Concentrations of total PCBs were greater than the organochlorine pesticides (Table 1). The average concentrations of total PCBs were elevated with a contribution range from 34% to 55% to the total UNEP POPs/PBDE load. BR from Tokyo-Snj had maximum PCBs concentrations whereas; minimum PCBs was observed in control WR. HxCBs were predominant homologues followed by HpCBs and PeCBs. Particularly, dioxin-like PeCB-118 was predominant contaminants in most rat while, HxCB-156 was greater in Landfill-Sp. Brown rat feed cables, electrical appliances, plastic and therefore PCB can easily ingested when they feed in and around electrical transformers/capacitors that runs in under grounds in Tokyo Metropolitan.

Table 2. Concentrations (pg/g fat wt.) and ranges of PCDD/DFs, dioxin-like PCBs (DLPCBs) and TEQ in Brown and Wistar rats.

Place of collection	Wistar Rat Lab. Control	Teuri-Is-Hk	Landfill-Sp	Tokyo-Snj	Tokyo-Ikb	Osaka-Umd	Osaka-Nnb
Sample number	n=3	n=1	n=3	n=3	n=3	n=3	n=3
Fat %	0.030 (0.028-0.035)	0.069	0.052 (0.035-0.074)	0.079 (0.054-0.094)	0.041 (0.034-0.047)	0.051 (0.044-0.065)	0.041 (0.032-0.051)
Sum PCDFs	69 (62-73)	1100	5100 (1900-8000)	4300 (1100-8800)	3500 (2400-5400)	1800 (1600-2000)	8800 (2000-17000)
Sum PCDDs	700 (640-740)	5100	6900 (4400-11000)	6100 (2800-9400)	8800 (7000-12000)	3900 (2900-4600)	12000 (2000-24000)
Sum PCDD/DFs	770 (710-810)	6200	12000 (6400-19000)	10000 (3900-15000)	12000 (9400-15000)	5800 (4500-6500)	21000 (4000-41000)
Sum non-ortho PCBs	99 (130-150)	1500	3000 (2400-3400)	73000 (650-220000)	3900 (3400-4400)	1300 (1000-1500)	4000 (2600-5800)
Sum mono-ortho PCBs	1300 (1000-1700)	8600	27000 (15000-40000)	430000 (11000-	38000 (28000-54000)	13000 (11000-17000)	30000 (22000-42000)
Sum dioxin-like PCBs	1400 (1100-1800)	10000	30000 (18000-44000)	500000 (12000-	42000 (31000-59000)	14000 (12000-18000)	34000 (27000-45000)
TEQ PCDFs	7.0 (5.9-7.9)	130	810 (320-1300)	1200 (150-3200)	600 (380-1000)	270 (260-280)	1200 (430-2300)
TEQ PCDDs	8.1 (7.3-8.6)	66	260 (130-350)	790 (55-220)	180 (150-210)	79 (72-84)	310 (160-560)
TEQ non-ortho PCBs	4.7 (2.7-6.4)	110	1700 (190-5500)	5400 (53-16000)	300 (270-350)	98 (83-110)	270 (200-420)
TEQ mono-ortho PCBs	0.17 (0.13-0.22)	1.4	9.2 (4.7-14)	120 (2.1-360)	5.8 (4.6-7.7)	2.1 (1.7-2.7)	5.8 (5.1-6.6)
Total TEQ	20 (16-23)	310	3000 (650-6600)	7500 (260-22000)	1100 (890-1500)	450 (430-480)	1800 (800-3300)

Mean and (ranges) of PCDD/DFs, DL-PCBs and TEQ were shown in Table 2. DL-PCBs were prevalent accumulants followed by PCDDs and PCDFs. The contamination of PCDDs and PCDFs were minimum (Table 2) with contribution of <2% to the total POPs/PBDE load. Maximum PCDD/DF concentrations have been noticed in BR from Osaka-Nnb followed by Tokyo-Ikb and Landfill-Sp while, Tokyo-Snj samples showed moderate concentrations. OCDD was greater in WR, while toxic congeners such as 23478-PeCDF, 1234678-HpCDD, 1234678-HpCDF was abundant in BR. The incinerator fly ash may be possible explanation for PCDD/DFs in BR. Furthermore varied food intake and/ or composition seems probable explanation for slight geographical variation. Individual analysis of DL-PCBs and PCDD/DFs showed not much variation in WR and BR from Teuri-Is-HK, Landfill-Sp, Tokyo-Ikb and two Osaka locations however, in Tokyo-Snj one rat accumulated elevated concentrations and thus testosterone suppression is expected in this rat[7].

TEQ concentrations were greater in Tokyo-Snj rat particularly one rat contained 22,000 pg/g lipid TEQ while other rats had comparable values that reported for Osaka and Tokyo-Ikb however, Landfill-Sp and Osaka-Nnb one rat showed moderately higher TEQ values. Comparatively higher TEQ in landfill probably due to feeding habit from garbage.

Greater concentrations of PBDEs also noticed in BR (Table 3). Particularly, BR from Landfill-Sp. had maximum concentrations followed by Tokyo-Snj. The contribution of PBDEs was 1%-28% to the total POPs/PBDE load. DeBDE was prevalent homologue in WR and BR from Teuri Is-Hk and Osaka. HxBDE-153 was greater in Landfill-Sp and Tokyo-Snj. The plastic samples dumped in landfill probably influenced greater HxBDE-153. The other predominant PBDE congeners in this study were TeBDE-47, DeBDE-209, HpBDE-183, PeBDE-99, -100 which, is somewhat different than other countries due to greater usage of DeBDE in Japan, while PeBDE was mainly used in other countries.

Table 3. Average concentrations (pg/g lipid) of PBDEs in Brown and Wistar rats.

Rat	Wistar Rat	Brown Rat					
Sample Name	Lab. Control	Teuri-Is-Hk	Landfill-Sp	Tokyo-Snj	Tokyo-Ikb	Osaka-Umd	Osaka-Nnb
TrBDE#28	46	45	970	77	370	110	130
TeBDE#49	38	<1	100	14	45	<1	<1
TeBDE#47	970	1,200	37,000	21,000	17,000	1,800	4,600
PeBDE#100	260	300	11,000	11,000	5,900	410	1,400
PeBDE#119	<1	<1	<1	1,600	170	<1	<1
PeBDE#99	330	160	8,000	2,600	3,900	530	1,200
PeBDE#85	38	N.D.	970	<1	310	34	81
HxBDE#154	<1	24	1,300	1,500	370	47	260
HxBDE#153	280	290	110,000	88,000	6,500	710	6,800
HxBDE#139	<1	<1	1,100	<1	270	24	110
HxBDE#138	<1	<1	3,100	340	370	32	200
HpBDE#183	100	160	33,000	1,800	1,100	750	5,700
OcBDE#197	180	290	22,000	2,100	1,200	1,300	4,800
OcBDE#196	<1	35	6,300	390	180	640	1,700
NoBDE#208	<1	110	3,600	700	340	1,600	2,000
NoBDE#207	470	310	8,400	2,000	660	4,100	3,100
DeBDE#209	6,000	3,600	74,000	7,500	11,000	73,000	26,000
Sum Major PBDEs	8,700	6,500	140,000	140,000	47,000	77,000	46,000

Detection limit 1 pg/g. The values rounded.

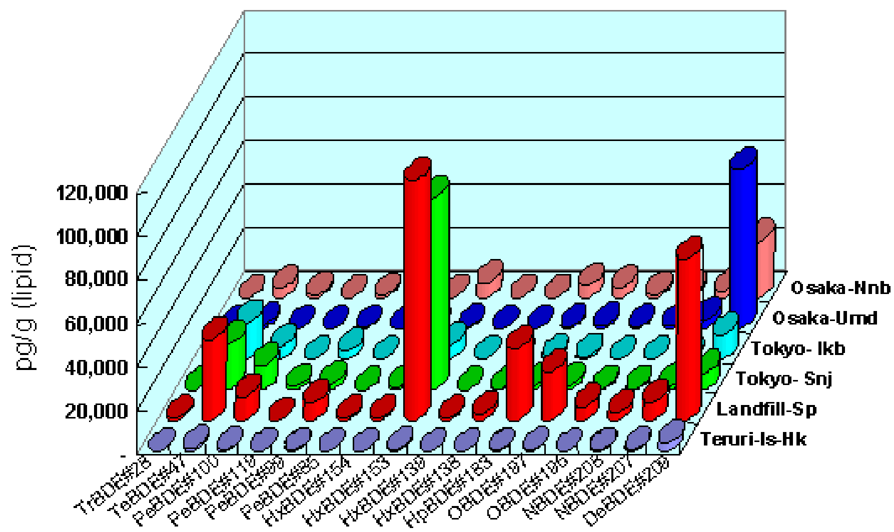

Figure 1. Congener specific accumulation of PBDEs in brown rat.

Since, brown rats live in close association with humans, contamination pattern in this species indirectly reflects the levels in humans since they feed mostly on human waste. BR will eat nearly any type of food. When given a choice, they select a nutritionally balanced diet, choosing fresh, wholesome items over stale or contaminated foods. They prefer cereal grains, meats and fish, nut, and some types of fruit. Food items in household garbage offer a fairly balanced diet and also satisfy their moisture needs. Based on this information's humans from Tokyo-Snj and humans lives near Landfill-Sp expected to intake comparatively greater organic chemicals. The result also reveals that BR could be used as bio-indicator species in order to understand the occurrence of toxic contaminants in and around human environment.

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