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The potential impact of PBDEs contamination on human health via oral media in E-waste dismantling area

Y. Yang[1], X. Li[1], R. Xu[1], M. Li[2*], Y. Yu[3*]

[1] *School of Environment & Safety Engineering, Changzhou University, Dist. 10, 213164 Changzhou, China*
[2] *Chinese Research Academy of Environmental Sciences, Dist. 10, 100012 Beijing, China*
[3] *South China Institute of Environmental Sciences, Ministry of Environmental Protection, Dist. 10, 50655 Guangzhou, China*

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PBDEs are a class of brominated persistent organic pollutants, which can be transferred via the food chain and finally cause damage to human health. The study on BDEs contamination via oral media, such as drinking water, soil and foods (dried sweet potato, rice, chicken, pork), was conducted in the E-waste dismantling area in Taizhou, Zhejiang province. The study included: BDEs concentration, distribution features and degree of exposure to human body. According to the calculation method for exposure dose developed by U.S. National Academy of Sciences (NAS), the exposure parameters were optimized and the daily average human exposure via oral media in the studied area was calculated. The analysis of the correlation between the exposure to drinking water and the serum concentrations of PBDEs showed a positive result. However, the serum concentrations of PBDEs did not correlate to other oral media. Therefore, the preliminary conclusion was that the amount of human exposure to drinking water in the studied area affected PBDEs concentrations in the blood. The study showed a significant correlation between the years of residence and the concentrations of PBDEs in the blood. The longer the residents lived in the locality, the higher was the blood concentrations of PBDEs in their bodies.

Key words: PBDEs, Oral media, Population, Health.

INTRODUCTION

Polybrominated diphenyl ethers (PBDEs) are a class of brominated persistent organic pollutants (POPs), commonly used as flame retardants, which include 209 monomers. Because of their excellent flame resistance, they are widely used in textiles, furniture, building materials, circuit boards, and plastic polymers for electrical appliances (such as television sets, computers, etc.)[1]. PBDEs tend to be stable in the environment, as they are hydrophobic, persistent, non-degradable, environmentally stable and bio-accumulated. They can be transferred via the food chain, poison the organisms existing in highly trophic environment and eventually damage human health [2,3]. It was reported throughout the study that PBDEs were detected in fish, human adipose tissue, blood and breast milk [4-6]. The relevant studies on the toxicity mechanism of PBDEs showed that they are toxic to the nerves, thyroid, reproductive organs, embryo, etc., and can disturb endocrine function, change the instinct behavior of animals, thus being potentially toxic to human beings [7-9].

Taizhou is situated in the southeast coastline of China. It is China's typical electronic waste dismantling area. In the late 1970s, some people in the area started to be engaged in dismantling work. Simple manual dismantling and direct combustion were the main treatment methods applied, e-wastes were not appropriately recycled, waste residues were directly thrown away. These dismantling activities caused serious PBDEs contamination in the area [10-13]. This study analyzed the content of PBDEs transferred via oral media in the area. The exposure calculation method recommended by EPA was adopted to analyze the correlation between PBDEs exposure and blood concentration. The preliminary study was conducted on the potential impact of PBDEs contamination on human health.

RESEARCH METHODS

Experiment

Reagents

The standard solutions of PBDEs were purchased from Accustandard (USA), recovery indicators including 13C-PCB141, PCB209 and internal standard 13C-PCB208 were purchased from Cambridge Isotope Laboratories (USA). BF-2000M-type Termovap Sample Concentrator was purchased from Beijing Dafang Century Technology Co. Ltd. Hexane, acetone and

* To whom all correspondence should be sent:
E-mail: limin@craes.org.cn,yuyunjiang@scies.org

methylene chloride were pesticide residues purchased from the Tedia Company (USA).

Sample collection and questionnaire

Altogether 60 samples of 0-20 cm-thick surface soil clods were collected in the electronic waste dismantling area in Wenqiao Town, Wenling city of Taizhou. The sampling instruments were inserted directly into the drinking water well collecting 34 water samples from the top, middle and bottom of the well for every 8 households. Corresponding to the location of soil samples, crops grown on each clod - 12 samples of dried sweet potato and 36 samples of rice, altogether 50 pieces, were collected. Pork samples from 4 pigs were purchased from the local farmers, 500 g fresh meat from the back and legs, respectively; chicken meat samples were collected from 4 chickens out of 4 households from different villages, back and legs of each chicken were cut off for backup.

For human blood samples, a cotton swab was damped with 75% ethanol, skin was wiped with 0.44 mol/L HNO_3, about 8 ml of venous blood was drawn with a vacuum tube, altogether 437 blood samples were collected from the studied area. After the samples were put aside for 15 min, they were centrifuged for 10 min at 3000 r/min (centrifuge radius=6 cm). Supernatant was put in a polyethylene centrifuge tube and immediately freezed at a temperature of -70 ˚C. Repeated freezing and storage were avoided.

The questionnaire was self designed based on the status in the studied area, concentrated discussions were held and consultation was conducted with experts in the area of epidemiology, environmental sanitation, etc., the information related to the questionnaire was verified and identified, which covered general and basic conditions, lifestyle, diet habits, etc.

Sample pretreatment was performed according to reference literature for pretreatment methods for water samples [14]. Water samples were filtered with glass fiber filter (Whatman, GF/F, 142 cm in diameter, 0.7 μm in aperture). Filtrates were loaded to a XAD2/XAD4 resin column (mass ratio 1:1), the organic compounds were enriched, recovery indicators 13C-PCB141 and PCB-209 were added, the resin column was washed with 50 mL of methanol and methylene chloride. The washed mixed resin was extracted three times with 50 mL of a mixture of dichloroethane and methanol (1:1 volume ratio) using a ultrasonic device; then 50 mL of saturated sodium chloride solution was added, and extracted four times with 50 mL of dichloromethane solution. Water was removed from the organic layer with anhydrous sodium sulfate column, rotated, evaporated and replaced with hexane, volume was set to 1 mL, and then transferred to a multi-grade composite silica gel/alumina chromatographic column for separation and purification.

The composite column was wet-loaded from bottom up as follows: 6 cm alumina, 2 cm neutral silica gel, 5 cm alkaline silica gel, 2 cm neutral silica gel, 6 cm acidic silica gel. Eluted with 50 mL hexane-dichloromethane solution (1:1 volume ratio), concentrated to 1 mL, then the volume was set to 0.1 mL using Termovap Sample Concentrator. The internal standard (13C-PCB208, 10mL×200ng/ mL) was applied for instrumental analysis.

Membranes were freeze-dried and weighed, and recovery indicators were added, a mixture of 400 mL of dichloromethane-acetone (1:1 volume ratio) was extracted with soxhlet for 71 h, activated copper was added to the extract to remove sulfur. The extracts were rotated, evaporated, condensed and then transferred to a multi-grade composite silica/alumina chromatographic column, the final volume was set to 1 mL.

The collected soil samples were taken to the laboratory in brown glass jars, placed in clean beakers (500 mL) baked at a temperature of 400ºC, and let to dry naturally in the darkroom. Sands, particles and other admixtures were removed from the samples, placed in a mortar for grinding, passed through a 0.85 mm aperture sieve, placed in a brown bottle and put in a refrigerator at a temperature of -4 ºC.

Filled silica gel column: the bottom of a glass column with diameter of 1.5 cm and length of 30 cm was covered with a small amount of glass wool, and then filled with 2 g of neutral silica gel, 5 g of alkaline silica gel, 2 g of neutral silica gel, 8 g of acidic silica gel, 2 g of neutral silica gel and 5 g of anhydrous sodium sulfate.

Before loading the samples, the silica gel column was activated with 50 mL of hexane, pre-rinsed with 20 mL of hexane, and then eluted with 100 mL of hexane-dichloromethane (1:1 volume ratio), the eluate was concentrated to 1~2 mL, transferred to the quantitative tube, 100 mL of nonane was added, the volume was reduced to 10 mL using Termovap Sample Concentrator, then the internal standard 13C-PCB208 was added for the measurement.

The chicken and pork samples were dissected to remove the internal organs which were then minced with tweezers and scissors, packed in bags, and sealed for refrigeration. The samples were ground

to powder in a mortar after which they were refrigerated and dried. About 5 g of dried muscles were weighed separately; recovery indicators 13C-PCB141 and PCB209 were added. About 15~25 mL of hexane-acetone (1:1 volume ratio) was used as the extracting agent for ultrasonic extraction for 10 min and the upper extract was removed. The residue was then extracted twice with 10 mL of ultrasonic extraction agent; the three extracts were combined and concentrated to 2~3 mL volume with nitrogen. About 1 mL of sample was taken and measured gravimetrically to determine the fat content, the rest was passed to a glass chromatographic column.

The components in the glass chromatographic column from bottom up were: cotton, 5 g of anhydrous sodium sulfate, 10 g of silica gel, 10 g of acidic silica gel and 10 g of anhydrous sodium sulfate. The concentrated extract was transferred to a glass chromatographic column which was eluted with 10 mL of hexane, then the washer-extractor with 30 mL of hexane-CH_2Cl_2 (1:1 volume ratio) was used for elution. After the liquid nitrogen was condensed and dried, hexane was used to dissolve the extract in the test bottle, 100 mL PCB208 (IS) standard solution was added and the volume was set to 50 mL using Termovap Sample Concentrator for instrumental analysis.

The collected dried sweet potato and rice samples were washed and mixed with a blender, freezed, dried and weighed, ground into powder, passed through a 0.18 mm sieve. 5 g of dried samples were taken separately, recovery indicators 13C-PCB141 and PCB209 were added, 250 mL of n-hexane-acetone (1:1 volume ratio) soxhlet were used to extract for 72 h. Extracts were concentrated to l mL using silica gel-alumina column chromatography for purification.

The components in the chromatographic column from bottom up were: cotton, 6 cm alumina, 2 cm deactivated silica gel, 5 cm alkaline silica gel, 2 cm deactivated silica gel, 6 cm acid silica gel and 2 cm anhydrous sodium sulfate. Eluted with 50 mL hexane - dichloromethane (l:1 volume ratio) mixture, internal standard $^{13}C-PCB208$ was added to the components, condensed and transferred to 2 mL sample bottle, volume was set to 100 mL using Termovap Sample Concentrator and the sample was stored in a refrigerator at a temperature of -4 ºC for analysis.

A 5 mL exact amount of human serum was drawn and inserted into a separatory funnel of polyvinyl chloride, recovery indicators (13C-PCB141and PCB209) and 2 mL 6 M hydrochloric acid solution were added, then 12 mL of isopropyl alcohol were added after shaking quickly and vigorously; 10 mL of the prepared mixed solution of hexane and methyl tert-butyl ether (1:1 volume ratio) were added, shaken, let stay still for phase separation, and the organic phase was separated. Then 10 mL and 5 mL of the above-mentioned mixture were used, respectively, for two-fold extraction, the three extracts were combined, washed with 5 mL dichloromethane solution (1%) and the latter was discarded. The organic phase was dehydrated with anhydrous sodium sulfate and dried, concentrated in a rotary evaporator to about 0.5 mL, transferred to the bottle for micro-cell, and dried with Termovap Sample Concentrator, the scale was weighed and the fat weight was obtained.

About 5 mL of hexane was used to dissolve fat and transfer it to a centrifuge tube, 2 mL of concentrated sulfuric acid was added, shaken, centrifuged, the upper part of the organic solution was transferred to another centrifuge tube, and hexane was used to extract the concentrated sulfuric acid. The organic phases were combined, rotated, evaporated and condensed to 1 mL, passed through acidic silica gel column dry-loaded as follows: 2 g acidic silica gel, 5 g neutral silica gel, 2 g acidic silica gel, 2 g diatomite, 2 g acidic silica gel, 5 g neutral silica gel, 2 g acidic silica. Then the organic phase was leached with a mixture of hexane and methyl tert-butyl ether (1:1 volume ratio). Again it was passed through silica gel loaded with: 5 g neutral silica gel, 3 g acidic silica gel, 3 g diatomite, leached with a mixture of hexane and methyl tert-butyl ether (1:2 volume ratio), rotated and evaporated to 0.5 mL, dried with Termovap Sample Concentrator, internal standard 13C-PCB208 was added, volume was set to 20 uL, sealed in a micro-cell bottle for analysis.

Instrumental analysis

The PBDEs samples were analyzed with Agilent 7890N gas chromatograph of high resolution (Wilmington, USA) coupled with an Autospec Ultima mass spectrometer of high resolution (Waters Micromass, UK). The ionization of the mass spectrometer was electron impact (EI). The electron emission energy was set to 35 eV. The data acquisition mode was SIR mode, with source temperature of 270ºC, carrier gas（He）flow velocity of 1.2 mL/min, R≥10000. Chromatographic column of DB-5MS（0.25 mm ID×0.25 μm) film. The temperature in the chromatographic column rose as follows：100ºC (2 min), ~230 ºC (15 ºC/min)，230~270ºC (5ºC /min)，270~330 ºC (8 min，10 ºC/min). Exactly 1 μL of sample solution was

injected with a CTC PAL auto sampler in splitless mode i.

Quality assurance and quality control

Quantitative analysis was performed using the internal calibration method and five-point calibration curves. The correlation coefficient of each calibration curve was greater than 0.99. The limit of detection (LOD), defined as a signal/noise ratio (S/N) = 3, was based on a 50 L water sample. The test limit of the method was: 2.2—108 pg/g. For each set of 10 field samples, a blank test was conducted. The results showed that all monomers of PBDEs were below the detection limit. The average recovery rates of the recovery indicators 13C-PCB141 and PCB209 were 83%~112% and 86%~120% respectively, both meeting the requirements for US EPA1614.

RESULTS AND DISCUSSIONS

Exposure Concentration to PBDEs via Oral Media

The PBDEs concentrations in drinking water, soil and foods (dried sweet potato, rice, chicken, pork) were tested and the results are shown in Table 1. Among the 6 media, low-brominated BDEs and high-bromo-PBDEs were detected, and the concentrations of the former were 35 to 495 times higher than of the latter ones. The low bromide ΣBDEs in soil were 1178.47 ng/g, and were the highest among all tested media.

Table 1. PBDEs levels in serum (ng/g fat).

	Mean	Std. deviation
BDE209	7.08	12.34
BDE077	4.03	15.75
BDE085	1.97	20.95
BDE126	6.68	18.42
BDE205	9.36	15.28
BDE203	4.34	13.49
BDE100	1.97	3.76
BDE119	9.94	10.75
BDE99	1.81	4.68
BDE118	4.40	11.94
BDE116	4.31	17.03
BDE85	2.28	3.59

The low bromide concentration contributed 48.9% to the soil contamination, among which BDE-47 had the highest concentration of 523.55 ng/g. The result shown in Fig.1 was similar to that found in Guangdong, China [15], Chicago, USA [16] and Kyoto, Japan [17]. The cause was analyzed and it was concluded that high-brominated BDEs, BDE-209 could be degraded in soil to low-brominated BDEs monomer (BDE-47) [18].

In the study on ground drinking water, BDE-1 and BDE-47 were found to be the monomers with higher concentrations, with concentration values of 1.81 ng/g and 0.79 ng/g, respectively. In comparison, the contribution of low brominated BDEs was higher. Chinese scientists found that BDE-47 was the main pollutant in the sea water of Pearl River Delta and the water for cultivation in Jiaozhou Bay [19], which was consistent with the findings of this study [20]. BDE-1, BDE-7 contents were found to be the highest in the four oral media: chicken, pork, rice and dried sweet potato. Researchers in China have found out that the highest detection rate and concentrations of BDE-47 and BDE-99 were in chicken in the e-waste dismantling area of Guangzhou [21]. BDE-47 and BDE-99 were also dominant in the fish samples in Yueqing Bay waters [22], in some foods from Dalian [23] and in carrots, spinach, etc. from Shanghai area [24]. The above-mentioned research findings on oral media are inconsistent with the findings of this study, probably because these four groups of studied organisms had different absorption and metabolism to BDE-47 [21].

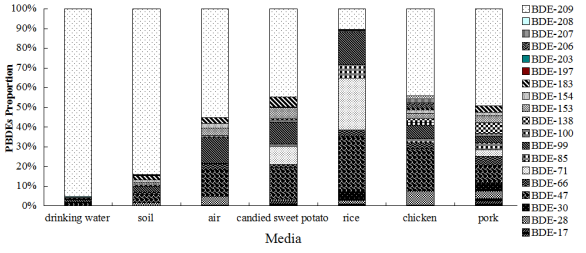

Fig. 1. PBDEs proportion in media.

Analysis on PBDEs concentrations in human blood

PBDEs enter the human body via oral media, air and other media when people are exposed to them in the environment [25]. The content and distribution model can be assessed by detecting the PBDEs levels in the blood. The highest BDE-47 content was found in the blood samples of Spanish infants studied by Meneses et al. [26] and in the blood samples of Belgian infants and mothers studied by Covaci et al. [27]. BDE-47 concentration among the homologous series of PBDEs was found to be the highest in the blood samples based on the following studies: blood tests of PBDEs affected population in North America conducted by Hites [28], blood tests of Norwegian men aged between 40~50 conducted by Thomsen [29], tests on samples of umbilical cords of Swedish infants and mothers' vein samples for PBDEs conducted by Sjudin [30]. Researchers from Indiana University [31] and Stockholm University [32] found from the analysis of blood samples of children in an e-waste

dismantling area that the content of low-brominated BDEs, such as BDE-47 and BDE-99, etc., was high and they could accumulate in the blood. The highest BDE-209 content was found in placenta tests of Danish women conducted by Frederiksen [33]. In addition, BDEs monomers were also found in samples of umbilical cords of Spanish infants and serum samples of their parents conducted by Gomarab [34]. Different levels of PBDEs were found in the blood samples of infants and their mothers in the test conducted in a city in the southern part of China by Qu [35]. The content of BDE-209 was found to be as high as 64.99 ng/g when testing PBDE in the serum of the workers in the e-waste dismantling area in Guiyu, Guangdong province, and those were metabolized and accumulated in the human body according to the study conducted by Ren [36] Gas chromatography/mass spectrometry approaches were adopted to detect PBDEs content in the blood of newborns in the e-waste dismantling region in Guangdong, and the distribution of PBDEs was discussed by Wu [37] The distribution of PBDEs in human blood was studied and the content was analyzed by Qu [38].

In this study, 12 kinds of PBDEs congeners were detected from 437 blood samples in the studied area, see Table 2 for the monomer concentration. The content of ΣPBDEs was 58.17 ng/g (fat) in the analyzed samples. BDE-119 contribution was the highest, up to 17.1% in total, followed by BDE-205 and BDE-209. BDE-47 was found to be with the highest content in the domestic and international studies on PBDEs accumulation in human body [28,39]. The contribution of each monomer to PBDEs in blood samples in the studied area was slightly different from the reported findings. The cause was explored and it was believed that some monomers could be converted into BDE-47 through body metabolism. PBDEs metabolites were found in rat

Table 2. Risk assessment of exposure parameters

Formula for daily soil exposure dose: $ADD(mg/kg\bullet day)\frac{CS\times IR\times FI\times EF\times ED}{BW\times AT}$	CS	mg/kg	*
	IR	mg/day	50
	CF	kg/mg	10-6
	BW	kg	62.5
	ED	a	30
	FI	%	1.0
	EF	days/year	365
	AT	days	Carcinogenic: 70×365 Non-carcinogenic: ED×365
Drinking water: $Intake(mg/kg\bullet day)=\frac{CW\times IR\times EF\times ED}{BW\times AT}$	CW	mg/L	*
	IR	L/day	2.0
	BW	kg	62.5
	ED	a	30
	EF	days/year	365
	AT	days	Carcinogenic: 70×365 Non-carcinogenic: ED×365
Diet: $ADD(mg/kg\bullet day)=\frac{CF\times IR\times FI\times EF\times ED}{BW\times AT}$	CF	mg/kg	*
	IR	kg/meal	0.104
	EF	meals/year	365×3
	FI	%	1.0
	ED	a	30
	BW	kg	62.5
	AT	days	Carcinogenic: 70×365 Non-carcinogenic: ED×365

Note: "*" is the actual value, others are reference values of US EPA.

Table 3. Daily exposure dose to PBDEs via environmental media in e-waste dismantling area (mg/kg·day).

Environmental media	Daily average exposure dose
Drinking water	0.0902
Soil	8.26×10^{-4}
Dried sweet potato	0.1926
Rice	0.3921
Chicken	2.0282
Pork	0.0136
Total daily dose of exposure	2.7175

feces by Maish [40]; BDE-209 was found to be metabolized and converted to BDE-47 and other monomers in rats experiment by Qiu [31,41]. Therefore, it could be preliminarily concluded that BDE-209, etc. in the samples tested by domestic and international scientists might have been metabolized to BDE-47, while BDE-209, etc. in the samples of this study have not been metabolized *in vivo*, but the rule of metabolism in other homologues needs further study. BDE-119, BDE-205 belong to the 5-brominated flame retardants which showed high contents in this study. The extensive use of such flame retardants in the studied area might be the cause for the difference between the obtained results and the findings by domestic and international scientists. The variance of domestic and international research findings may relate to race, lifestyle, genetics and polluting factors.

Daily average exposure amount via oral media

Studies have shown that PBDEs were accumulated in large amounts inside the organisms after they were absorbed via the food chain, while the human being as the terminal of food chain, took in huge amount of PBDEs from foods [36]. The daily average exposure amount by the population in the studied area via oral media was calculated for this study by adopting the exposure dosage calculation method of the four-step approach proposed by U.S. National Academy of Sciences (NAS), based on questionnaires and optimized exposure parameters actually measured, see Tables 2, 3. It is obvious that the daily average exposure amount of 2.71 mg/kg/day to ∑PBDEs by the population in the studied area is much greater than the risk dose of 0.01 mg/kg/day issued by EPA.

Both domestic and international studies have shown that the amount of PBDEs intake via oral exposure pathways should not be ignored [42]. It was found that poultry and meat products accounted for 60% to 70% of the Americans total intake of PBDEs via foods. Canadians took in 44 ng/g of PBDEs per day from foods [43,44]. The highest concentration of PBDEs was found in poultry, fatty foods and in animal liver. In Sweden [45] Finland [46], local residents took in 47% and 55%, respectively, of the PBDEs via eating high-fat food. 50% of Swedish intake of PBDEs was from high-fat food. The average concentration of PBDEs in the body of those people who didn't eat fish was 0.4 ng/g (fat), while the PBDEs level was 2.2 g/g (fat) [47] in those people who ate fish 10 to 20 times per month. Lind [48] pointed out that high-fat food was the main source of PBDEs intake accounting for two-thirds of the total intake. Otha [49] found that vegetables and grain could absorb PBDEs from the air and PBDEs entered the body via food chain resulting in accumulation.

Potential impact of PBDEs contamination on human health via mouth media in e-waste dismantling area

Domestic and international reports have found that smoking and drinking status, amount of fruit intake, water intake, all had great impact on human metabolism and absorption capacity. Correlation analysis was conducted on PBDEs content in the blood of the studied group with its relevance with gender, age, smoking, drinking, fruit and food intake, water intake and other factors. The results showed that the blood levels of PBDEs did not correlate with gender. The correlation analysis, conducted on different age groups for PBDEs in human blood found that PBDEs concentration in the blood of people aged between 30 to 45 years correlated with age (P=0.031). According to the actual survey and the epidemiological statistics, this age group probably lived in the studied area when e-waste dismantling industry was most prosperous. The accumulation of PBDEs in the blood correlated with alcohol (P = 0.047) and did not correlate with other confounding factors [50].

The data collected from the questionnaire regarding the studied subjects were: years of residence, lifestyle, diet habit etc.; the daily average exposure to PBDEs via oral media was calculated, and its correlation with PBDEs accumulation in the blood was analyzed (Table 4). The findings showed that years of residence obviously correlated with PBDEs concentration in blood:

Table 4. Correlation between years of residence and blood concentration exposure dose via oral media.

Correlation	Residence	Exposure dose via oral media					
		Drinking water	Soil	Dried sweet potato	Rice	Chicken	Pork
Correlation coefficient	0.963	0.879	0.434	0.561	0.465	0.519	0.442
P	0.005**	0.045*	0.489	0.285	0.456	0.311	0.483

*P<0.05 closely related **P<0.01 closely related.

The longer they lived in the locality, the higher was the PBDEs accumulation in the blood. Only the oral exposure pathway in the studied area was considered for this study, no occupational exposure was studied. The correlation analysis on the oral exposure dose with serum accumulation of PBDEs showed that it obviously correlated with the exposure to drinking water, and did not correlate with any other media. Therefore it can be preliminarily concluded that the exposure dose to drinking water by the people in the studied area affected the accumulation in the blood. Whether it is due to the human function of metabolizing drinking water was not reported at home or abroad, and it requires the support by the results of toxicology tests on animals.At present the toxicology study on PBDEs mainly relies on animal experiments. Eriksson [51] exposed rats and mice to BDE-209 with purity of 94% to 97%, the results showed that the incidence of liver tumors in rats and mice significantly increased. The exposure via oral media to male rats, mice, female rats, mice was 2240 mg/kg·day, 1120 mg/kg·day 2550 mg/kg·day, and 1200 mg/kg·day, respectively. The animal tests conducted by U.S. NTP [52] found that after rats and mice were exposed to BDE-209 at a dose of 0.25 mg/kg and 50 mg/kg, respectively, for 103 weeks, those with high dose had significantly higher incidence of liver cancer and pancreatic cancer, and slightly higher incidence of thyroid follicular cells adenocarcinoma and cancer. Vberg [53] found that administering BDE-209 with different single dosage to rats during their rapid growth period (postnatal 3rd day, 7th day, 10th day) for interventions could affect neurotransmitter secretion, resulting in neurobehavioral changes in rats with neurodevelopmental toxicity. Hites [54] tracked male mice after they were exposed to BDE-47 (10.5 mg/kg) once on the 10th day of birth and found that BDE-47 was toxic to the nervous system, and the effects increased with age and became more pronounced. Many domestic and international experiments on animals showed that PBDEs caused harm to the nervous system which was genetic [55]. Birmbanm [56] found out from the study on the toxic effects on male rats that the concentration of thyroxine decreased while thyroid-stimulating hormone concentration increased, the enzyme activity of EROD, PROD and UDPG inside rats increased when the concentration was 30.60 mg/kg. Stoker [57] studied male and female mice, and found out that the serum thyroxine of male mice significantly increased when exposed to PBDEs with a dose of 30.60 mg/kg on the 21th day of birth, same with female rats when exposed to doses of 3.30 and 60 mg/kg on the 31th day of birth.

CONCLUSION

It is quite obvious that PBDEs contamination has been accumulated in the blood of the residents in the studied area, and the results correlated with the oral route of exposure to certain extent. Many domestic and international experiments on animals have shown that the toxicity of PBDEs is diversified. Although there are reports available regarding the amount of PBDEs accumulation in the human body and the risk values of daily exposure to PBDEs proposed by EPA, the damaging effects of PBDEs contamination on human health and their accumulation are rarely known and will be further studied.

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ПОТЕНЦИАЛНО ВЪЗДЕЙСТВИЕ НА ЗАМЪРСЯВАНИЯ ОТ ПОЛИБРОМИРАНИ ДИФЕНИЛОВИ ЕТЕРИВЪРХУ ЧОВЕШКОТО ЗДРАВЕ В ПЛОЩАДКИ ЗА ОБЕЗВРЕЖДАНЕ НА ЕЛЕКТРОННИ ОТПАДЪЦИ

Я. Янг[1], Кс. Ли[1], Р. Ксу[1], М. Ли[2*], Ю. Ю[3*]

[1]*Училище по екологично инженерство и сигурност, Университет в Чангжоу, Китай*
[2]*Китайска изследователска акадмия по екологични науки, Бейджин, Китай*
[3]*Южнокитайски институт по екологични науки, Министерство по опазване на околната среда, Гуангжоу, Китай*

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(Резюме)

Полибромираните дифенилови етери (PBDE) са клас от устойчивите бромирани органични замърсители, които се пренасят чрез хранителната верига и могат да причинят увреждания на човешкото здраве. Изследването на заразявания с BDE чрез устата, например с питейна вода, почва или храна(сушени сладки картофи, ориз, пилешко, свинско месо) е проведено в района Таижоу (провинция Жейианг) в район за разкомплектоване на електронни отпадъци. Изследвани са концентрациите на BDE, тяхното разпределение и степента на експозиция за човешкото тяло. Параметрите на експозиция и дневните дози, приети орално в изследвания район са определени съгласно изчислителната методика за дозата на експозиция, разработена от U.S. National Academy of Sciences (NAS). Анализът на корелацията между експозицията на питейна вода и концентрацията на PBDE в кръвен серум показва положителен резултат. Обаче серумната концентрация на PBDE при други орални заразяванияне се корелира. Затова предварителното заключение е че количеството приета питейна вода влияе върху съдържанието на PBDE в кръвта. Изследването показва значителна корелация между годините престой и концентрацията на PBDE в кръвта, като последната се повишава с увеличаването на живота в засегнатия район.