POLYCHLORINATED BIPHENYLS AND POLYBROMINATED DIPHENYL ETHERS IN HUMAN BREAST MILK FROM MOTHERS LIVING IN COASTAL AREA OF SURABAYA CITY, INDONESIA

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Introduction

Polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) are ubiquitous environmental contaminants used in industrial application and household products, respectively. PCB mixtures were largely used as dielectric fluids in transformers and capacitors, whereas PBDEs are well known additive flame retardants in many consumer products (i.e. furniture, textiles, computers, household appliances, electronics and TV-sets)[1]. These chemicals have been recognized to persist in the environment and accumulate in lipid–rich body tissues. Environmental contamination by these persistent organic pollutants (POPs) have been widely reported in various environmental and biotic matrices of many Asian countries [2,3,5,6,17], such as PCBs and PBDEs contamination in breast milk of different countries[2–5, 7–12], indicating their worldwide contamination. On the other hand, breast milk is known as a very important food for infants because it contains not only nutrients (proteins, amino acids and carbohydrates) but also non-nutritive factors such as enzymes, hormones and immunoglobulins which are essential for growth[13]. These two contradictory issues are the basis for the present global concern to monitor POPs in human breast milk. Such chemical analyses are crucial for determining the levels in humans; examine the effects of exposure times and for estimating the detrimental factors for the breastfeeding infants. The present study aimed to characterize PCBs and PBDEs contamination in human breast milk collected from mothers living in Kenjeran, a coastal area of the highly industrialized city of Surabaya, Indonesia.

Materials and methods:

Samples

A total of 28 breast milk samples collected from mothers living in Kenjeran, a coastal area of Surabaya City, East Java Province, Indonesia were used in this study. A questionnaire survey was also performed to collect information related to donor characteristic and exposure scenario such as age, body weight, height, dietary fish, parity, lactation period, occupation, etc., from all mothers. The questionnaire procedure described previously by Sudaryanto et al. (2008) and Tue et al. (2010) [4,5] was used with slight modification. Breast milk samples were deep-frozen before transporting and storing at -25^{o}C in the *es*-BANK of Ehime University, Japan, prior to chemical analysis.

Chemical analysis

Identification and quantification of PCBs and PBDEs were performed by a GC (Agilent 7980A) coupled with MS (Agilent 5975C). DB–1MS fused silica capillary column (30 m x 250 µm i.d. x 0.25 µm film thickness) was used for mono- to hepta–BDEs and PCBs, while a VF–1MS capillary column (15 m x 250 µm i.d. x 0.1 µm film thickness) was used for octa- to deca–BDE. Forty two PBDE congeners from mono– to deca–BDE and 62 PCB congeners were quantified in this study. Concentrations of PBDE and PCB congeners were summed to determine the total concentrations which were expressed both as ng g^{-1} ww and ng g^{-1} lw. The chemical analyses were carried-out following the methods described elsewhere[3,5,14].

Results and discussion:

Levels and contamination status

Concentrations of PCBs and PBDEs in mothers' milk from all the samples analyzed are shown in Fig. 1. Results of individual samples indicated that human breast milk of the present study have widely been contaminated by these compounds. The contamination level of PCBs (7.7 – 75 ng g^{-1} lw) were significantly higher than PBDEs (0.089 – 13 ng g^{-1} lw) (p < 0.001; Mann-Whitney U–test), indicating the possible higher bioaccumulation and bioavailability of PCBs than PBDEs. In addition, the higher PCBs production and usage in the past which is associated with long exposure period to human could also be the other reason for higher concentration of PCBs than PBDEs in human.

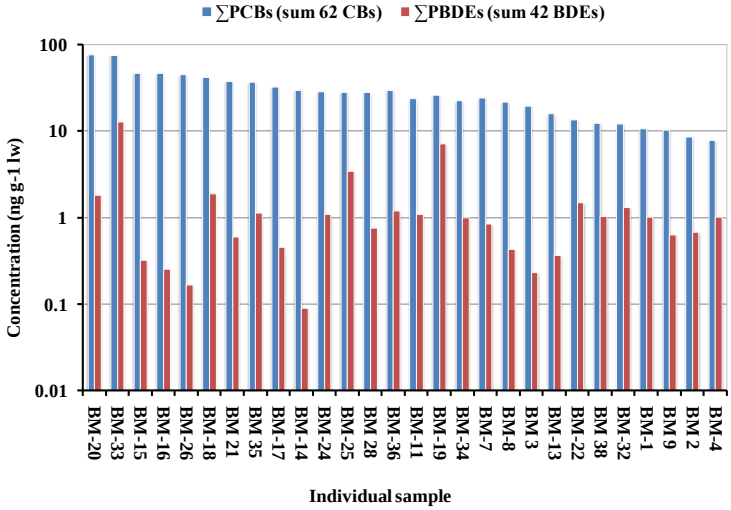

Fig.1 Concentrations of total PCBs and PBDEs in individual samples from Kenjeran, Surabaya, Indonesia.

In this study, we observed significant positive correlations between lipid contents and total PCBs (r = 0.51) for almost all the CB congeners (data are not shown). Similarly, frequency of consumption of fish diet was also found to be significantly associated with levels of CB187, -183 and -180, whereas, negative correlations were found between lactation period and levels of CB28, -138 and -170. Some other factors such as body mass index, age, parity, period of stay at home and the length of time used for attending house work as housewife were not significantly correlated with both PCBs and PBDEs (data not shown). Previous studies also reported no correlation between PBDE levels in human breast milk and age and lactation period in Sweden[20], Norway[16] and U.S. mothers[7]. In this study, levels of PCBs and PBDEs were significantly correlated (R^2 = 0.45; p < 0.05), indicating that they have similar sources or pathways of human exposure. Further studies are needed to reveal the exposure pathways of these compounds in the area of study.

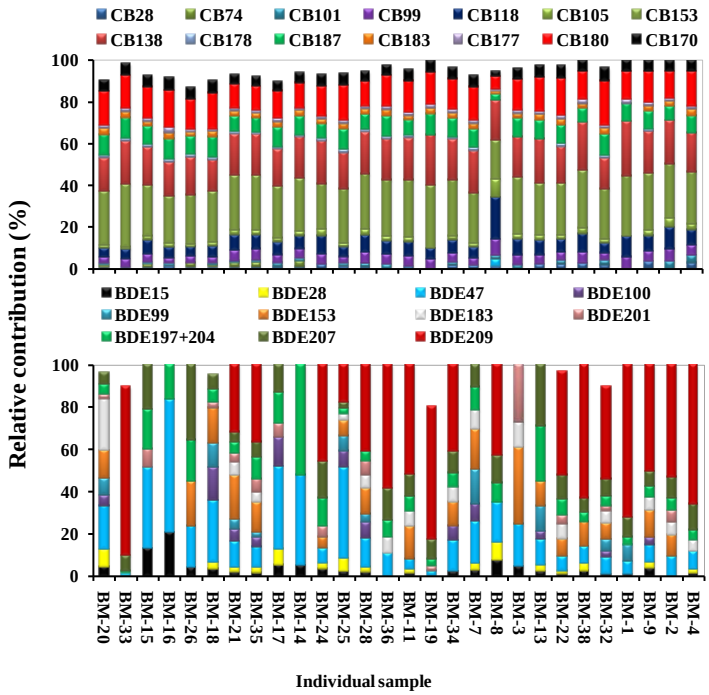

Fig. 2 Profiles of selected PCB and PBDE congeners in individual samples from Kenjeran, Surabaya, Indonesia

Mean concentrations of PCBs (29 ng g^{-1} lw) and PBDEs (1.6 ng g^{-1} lw)

were within the concentration ranges of those reported from some other cities in Indonesia such as Jakarta, Bogor, Purwakarta and Lampung[17], but lower than those from Malate, the Philippines[14] and Venice, Italy[8].

Congener profiles

The profile of selected congeners for PCBs and PBDEs are shown in Fig. 2. Even though, most of the PCB and PBDE congeners from di- to deca- were detected, generally, PCBs were mainly consisted of CB153, -138, -180, -187, -118, -170 and -99, while BDE47 and -209 were the dominant PBDE congeners. Polder et al. (2008) found CB153, -138, -180, and BDE47, -153 and -209 as predominant congeners in breast milk samples from Northern and Southern Norway[10], which is similar to this study. The major usage of PCB product mixtures containing penta– to hepta–CBs in Surabaya could be one of the reasons. In addition, physicochemical properties of higher CB congeners such as higher lipophilicity and persistence could also be suitable explanations. The fish diet was the possible factor associated with the PCB levels in human breast milk from the coastal area of Surabaya. Ilyas et al. (2010) reported similar profiles of PCBs in wild fish and shellfish from coastal waters of Surabaya City[18]. Pearson correlations indicated significant relationships between fish diet and some congeners of CB such as CB187, -183 and -180 in this study. Significant positive correlation between PCB levels in human breast milk and the frequency of fish consumption of mothers have also been reported in Ontario Lake[19].

Darnerud et al. (2001) reported that food items were major routes of human exposure to PBDEs[15]. However, direct exposure to PBDEs was also possible through daily usage of commercial products containing BFRs and/or inhalation of indoor house dust, mainly for the accumulation of lower congeners of PBDEs such as BDE47 and -99. It has been reported that higher brominated BDE congeners such as hepta- to deca-BDE were less efficient in transferring from blood to breast milk compared to lower PBDEs, and also the former compounds have low bioaccumulation potential as well[15]. Occurrence of some higher molecular weight PBDEs such as BDE209, -201 and -183 in the present study may be due to the large amount usage of Deca-BDE formulation and its debromination products[21,22].

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