DIETARY EXPOSURE TO PBDES AND LEVELS IN BREAST MILK OF WOMEN LIVING IN CENTRAL ITALY

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Introduction

In recent years, a marked increase in the levels of PBDEs in human biological tissues and fluids, especially breast milk, has been observed in some countries[1,2]. It seems that, for the general population, one of the main routes of exposure to PBDEs, particularly the lower brominated congeners, is through diet, as also occurs with PCDD/PCDFs and PCBs[3].

Previous reports have shown a high correlation between PBDEs in mothers' milk and foetal exposure. Breast milk can reflect the maternal body burden and infants' postnatal exposure and increased PBDEs in breast milk have been related to decreased birth weight, length, chest circumference and body mass index of infants[4].

In spite of the great interest in evaluating the presence of these chemicals in food, in Italy most of the existing data regard fish and seafood and cow milk, which have often been used to evaluate environmental contamination. No specific data are available for Tuscany or central Italy.

The concentrations of PBDEs in the breast milk of women living in the city of Siena (Central Italy) and its province and in food, purchased from supermarkets in the city, were determined to ascertain the relationship between the levels found in the diet and in humans. The aims of this study were:

- to assess human exposure to the contaminants of interest through determination of the presence and levels of contaminants in human milk;
- to achieve representative data on the levels and distribution of PBDEs in food consumed by the population in the study area;
- to estimate the intake of contaminants through diet and the relative contribution of different food groups.

Materials and methods

This work is part of a series of studies on the contamination of human milk, adipose tissue and food carried out in the same area over the last 20 years[5,6,7,8,9,10,11].

The analyses were carried out on samples of milk from breastfeeding women within a week of delivery and on a large number of food products commonly included in the typical Italian diet.

Breast milk (approximately 50 ml) was collected from 47 breastfeeding women within a week of delivery. The age of the women varied between 23 and 37 years old. The lifestyle and dietary habits of each woman were determined using a self-reporting questionnaire. All the women were from the Sienese area and could reasonably be expected to obtain some of their food products from the supermarkets where the food products analyzed were purchased.

The 339 pools of food samples were homogenized and analyzed: the method followed is described elsewhere[12] and briefly consists of a Soxhlet extraction, a multilayer chromatographic column clean-up and GC-MS determination.

The quality of the analyses was assessed by sample addition with recovery standard (PCB^{13}C-141), certified materials analysis (WMF-01 and ERM-IRMM) and blanks analysis (one every five samples). The LOD of single compounds was about 0.04 ng/g wet weight (w.w.) and 0.9 ng/g lipid basis (l.b.). Median and mean values were calculated in lowerbound.

As the data sets were not normally distributed, statistical analysis was performed using the Mann-Whitney *U*-test and the Spearman correlation.

Results and discussion

The results of the analysis of PBDEs in food products in Siena are reported in table 1.

In all the food categories in which PBDEs were present at detectable levels, tetrabrominated and pentabrominated DEs prevailed, confirming the data reported in the scientific literature[13].

In "fish and seafood" the congener 47 was always present (where PBDEs were detectable) and the order of prevalence was: BDE-47> BDE-99> BDE-100. The congeners 49 and 77 were detected in a very limited number of samples. The median concentration for the food category "fish and seafood" in this study (2.60 ng/g w.w.) was greater than that reported for food on the U.S.A. market[14] (1.72 ng/g w.w.) and the mean was greater than that reported for food on the Swedish[15] market (0.63 ng/g w.w). The PBDEs congeners did not show a common trend in meat samples and were detected only in a limited number of pools. The mean of the PBDE values was 25.74 ± 101.87 ng/g w.w. and the median was <LOD, while the scientific literature[14,16] reports median levels of PBDEs of 0.11 ng/g w.w. and 0.28 ng/g w.w for foodstuffs from the U.S.A. and Spain respectively. A much lower mean value (0.046 ng/g w.w.) has been reported for meat from the Swedish market[15].

Table 1- PBDEs in food products.

Food group	∑**PBDEs** (ng/g w.w. / l.w.)	
	Mean±SD	Median
cereals and tubers	<LOD	<LOD
fish and seafood	95.96±371.62 / 827.23±5284.56	2.60 / 66.06
meat	25.74±101.87 / 214.69±538.12	<LOD
eggs	<LOD	<LOD
milk and dairy products	5.79±12.17 / 24.18±49.21	<LOD
fruit and vegetables	<LOD	<LOD
oil and fats	<LOD	<LOD
sweet foods	<LOD	<LOD
special foods and mixed dishes	0.10±0.28	<LOD
beverages	<LOD	<LOD

In milk samples PBDEs were always <LOD and the PBDE congeners also failed to show a common trend in samples of dairy products. The mean of the values was 8.37 ng/g w.w., while the literature[16] reports a lower median level of PBDEs (0.02 ng/g w.w.) for dairy products from Spain. In the same Spanish study[16] the mean concentration of PBDEs in milk was 0.04 ng/g l.b.

Combining the data of food consumption and the median values of concentration of contaminants, the weekly dietary PBDE intake assessed in this study was 76 µg (0.18 µg/kg b.w. if calculated for a person weighing 60 kilograms). The scientific literature reports lower data for other populations: for Spain the weekly dietary intake has been estimated at 4.9-5.6 µg[13], while other studies have shown a daily intake of 2.1-4.5 µg for Sweden[15], Canada[17] and the U.K.[18]. Given the high discrepancy between the median and the mean of values, using the median instead of the mean to calculate the weekly intake, it results 0.54 µg . Contributions of food categories to the dietary intake of PBDEs, together with food consumption data for the population of central Italy[19] are reported in figure 1. A previous study[13] confirmed that about 1/3 of the total dietary intake of PBDEs derives from fish and seafood.

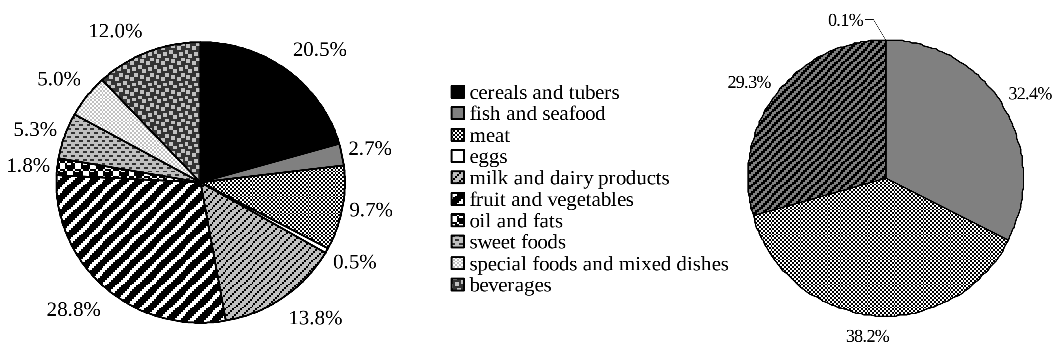

Figure 1- Food consumption data (left) and contributions of each food category to dietary intake of PBDEs

The high dietary intake assessed for the population of the Sienese area was confirmed by the high concentrations of PBDEs in breast milk collected from resident women (comparison with literature data in figure 2). Levels of PBDEs in breast milk from women in Siena (mean value ± standard deviation: 56.27 ± 90.03 ng/g l.b. and median 38.65 ng/g l.b.) were not significantly associated with maternal age or prevalent consumption of foods from the most contaminated categories. PBDE-47 and PBDE-99, which are the most commonly detected in the environment and organisms[20], were the prevalent congeners (figure 3) and the characteristic profile was not occupational/work-related (BDE-153< BDE-47). The isomer pattern of breast milk samples is reported in figure 4 and confirmed by another study[21].

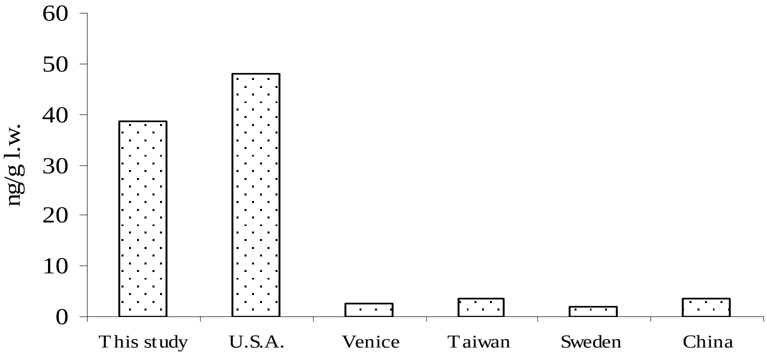

Figure 2- Comparison of median values from this study with those of others on PBDE levels in breast milk from the U.S.A.[22], Venice[23], Taiwan[24], Sweden[25] and China[26].

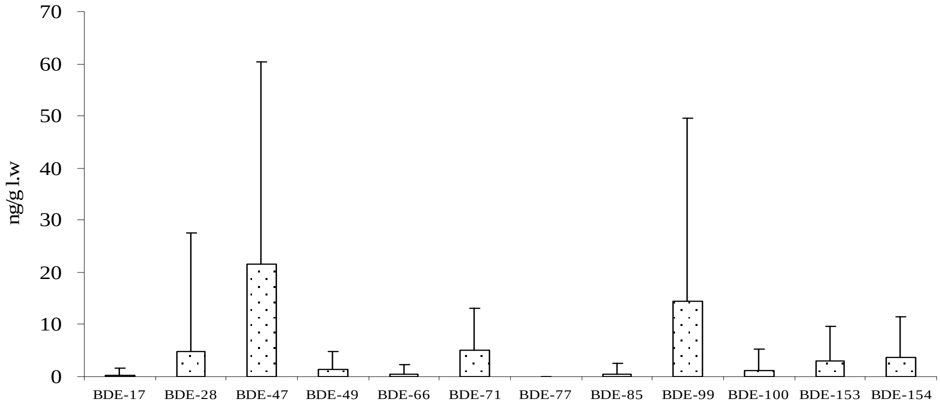

Figure 3- Congener profiles in breast milk from Siena.

Further research is needed on causes of the high levels of PBDEs found in food and human milk, and possible correlations between the exposure to these compounds and potential specific diseases in the studied population.

WHO encourages and supports breast feeding, lacking sufficient scientific evidences on risks due to contaminants presence in milk, and above all considering the psychological and nutritional importance of this practice. Nevertheless further measures must be adopted to assure that the decreasing of contaminants' concentrations, started in '90, can continue. Advantages of breast feeding are substantial and the best way to maximize these benefits is reducing maternal exposure to contaminants, mainly avoiding or limiting the consumption of potentially contaminated food.

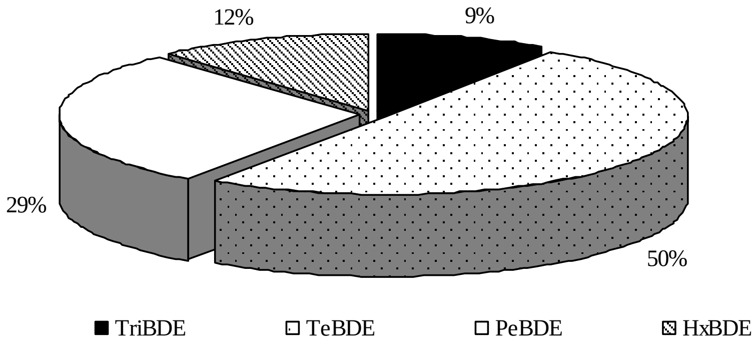

figure 4- Isomer profile of breast milk from women in Siena.

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