

PBDE's in US human milk, archived and recent blood, fetal liver, partitioning between milk and blood, cooked and uncooked food, and environmental specimens

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Abstract

This paper presents data from our ongoing study on levels and intake of 13 PBDE congeners in US milk, blood, fetal tissue, milk and blood partitioning, food and environmental samples. We found contamination in all human milk and blood and at the highest levels worldwide, 10-100 times European levels. We found contamination of all US food except fat free milk, also at the highest levels worldwide. Archived blood from 30 years previously had extremely low PBDE levels compared to present day specimens but much higher levels of dioxins, dibenzofurans and PCBs. Levels in food are highest in fish, then meat, then dairy; however, in the US intake of PBDEs is highest from meat, then dairy, then fish. Fetal and newborn livers were found to all be contaminated with PBDEs thus documenting transplacental transfer; the levels were considerably lower than US adult levels on a lipid basis in blood or milk. Partitioning data between blood and milk from the same mothers showed a higher ratios for more brominated congeners, above 1.0, and ratios less than 1.0 for the less brominated congeners; these findings are similar to our previous partitioning data for blood and milk dioxins and dibenzofurans. High levels of PBDEs were found in household carpet sweepings and computer casing wipes, with BDE 209 especially prominent. All media tested showed wide variations in levels and patterns. For example, blood and milk varied from 4 to over 400 ppb lipid in humans.

Results

Polybrominated diphenyl ethers (PBDEs) were found to be higher in US nursing mothers by about a 10-100 fold factor compared to European mothers who were higher than Vietnamese mothers' milk¹. The distribution of PBDEs in our US blood and milk are similar on a population basis.

Table 1. Median PBDE levels

| | Sum PBDEs Median (ppt, ww) |
|------------|-------------------------------|
| Fish N=19 | 581 |
| Meat N=13 | 129 |
| Dairy N=13 | 81 |
| Misc N=4 | 0 -> 115 |

Table 2. Lipid and PBDE level change with cooking

| | Lipid % | | Total PBDEs (ng ww) | |
|---------------|---------|-------|---------------------|-------|
| | Before | After | Before | After |
| Ground beef | 30.7 | 20.7 | 64.4 | 19.1 |
| Ground lamb | 19.7 | 16.4 | 41.2 | 15.7 |
| Pork sausage | 24.4 | 26.6 | 33.6 | 54.7 |
| Catfish | 5.2 | 3.3 | 92.0 | 43.1 |
| Rainbow Trout | 10.1 | 12.9 | 272 | 259 |
| Salmon | 12.3 | 7.8 | 132 | 115 |

Table 3. Blood/milk ratio. N=8

| Congener | Number of bromines | Minimum | Mean | Median | Maximum |
|----------|--------------------|---------|------|--------|---------|
| BDE #28 | 3 | 0.50 | 0.67 | 0.64 | 1.07 |
| BDE #47 | 4 | 0.64 | 0.76 | 0.78 | 0.84 |
| BDE #99 | 5 | 0.56 | 0.73 | 0.77 | 0.84 |
| BDE #100 | 5 | 0.60 | 0.77 | 0.79 | 0.87 |
| BDE #153 | 6 | 0.93 | 1.17 | 1.09 | 1.61 |
| BDE #154 | 6 | 1.02 | 1.42 | 1.35 | 2.33 |

Comparing blood from 1973 with 2003 we found dioxins, dibenzofurans and PCBs much higher and PBDEs much lower in 1973 than in 2003². Table 1 presents levels of PBDEs found in a market basket survey for showing fish highest, then meat, and dairy products lowest in PBDE contents³. However, US intake data

showed meat contributes most of food to intake with dairy second and fish least. Table 2 shows the effects of cooking, broiling or microwaving with fat allowed to drip off, on PBDE levels for a given portion of fish or meat; it shows similar findings to our previous studies on dioxins

with frequent decrease in levels with cooking⁴. Table 3 shows partitioning of blood and milk from the same mothers for selected PBDE congeners. A pattern similar to that found with dioxins can be observed with higher ratio for the more halogenated compounds and lower ratios for the less halogenated compounds⁵. Table 4 shows the total PBDE levels found in fetal liver. This documents, for the first time, we believe, levels of PBDEs in human liver, the transplacental movement from mother to fetus of PBDEs and lower levels which exist here, 4-33.4 ppb, compared to the 4-413 ppb we found in human blood or milk lipid^{1, 2}. We previously reported findings of PBDEs on computer casing wipings and household vacuum sweepings. Wide range of values was noted and BDE 209 was frequently prominent⁶.

Table 4. PBDE levels in fetal liver.

| Sample | Gestation age (wk) | Stillborn (Yes/No) | Time lived | Total (ppb lipid) |
|--------|--------------------|--------------------|------------|-------------------|
| 1 | 23 | N | 2 3/4 hrs | 4 |
| 2 | 23 | N | 3 hrs | 6.5 |
| 3 | 24 | N | 3/4 hrs | 9.8 |
| 4 | 38 | Y | na | 10.4 |
| 5 | 39 | N | 2 days | 12.3 |
| 6 | 21 | N | 4 hrs | 15.2 |
| 7 | 34 | N | 2 hrs | 16.4 |
| 8 | 33.5 | Y | na | 21 |
| 9 | 39 | Y | na | 26.3 |
| 10 | 20.5 | Y | na | 33.4 |

Discussion

PBDEs have been found in all US human tissues, food, and environmental samples tested. The levels appear to be the highest in the world, especially for human tissue and to a lesser extent food. Archived blood from 1973 shows much lower PBDE levels than currently exist but much higher levels of dioxins, dibenzofurans and PCBs. The route of intake of PBDEs into humans appears at least partially from food but possibly a smaller percent intake is from food than is the case for dioxins. Further research is needed to more adequately expand these early data to possibly be more representative samples, to determine transport and fate, and health consequences to humans of these compounds.

BDE 209, although difficult to measure because of external levels in blanks, was found in blood, milk, food and especially high levels were found in environmental samples of vacuum sweepings and computer casing wipes.

PBDEs, lipid soluble persistent organic pollutants similar structurally and toxicologically to PCBs, are rapidly increasing in the US environment including human tissues⁷. Levels in humans, food and the environment appear to be highest in the USA. These present a potential public health threat and are worthy of further study. Especially absent are studies on health effects on as well as comprehensive distribution studies in humans, food and the environment in the USA, in Europe and in less developed countries. With large amounts of PBDEs in the

environment and the continued manufacture of the Deca commercial mixture, these are likely to present long term pollution problems, especially in the USA.

References

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