BROMINATED FLAME RETARDANTS IN THE USA AND SELECTED OTHER COUNTRIES IN MILK, BLOOD, FOOD, FAST FOOD, AND AIR

Schecter A J[1], Päpke O[2], Shah N C[1], Harris T R[1]
1. University of Texas School of Public Health, 6011 Harry Hines Blvd, Dallas, Texas, USA;
2. Eurofins-ERGO, Geierstrasse 1, Hamburg, Germany

Abstract
A selective update of our recent research is presented which describes polybrominated diphenyl ethers (PBDEs) in milk from US and other countries and in US blood, food, fast food, and air. US milk and blood levels remain the highest in the world [1]. Food levels are high but not by as great a factor as blood or milk [2, 3]. PBDE intake levels are calculated for US adults and infants from food, dust and air. New (2006) Vietnam milk PBDE levels and patterns are compared with US PBDE levels.

Introduction
We and others have documented high and rapidly increasing levels of PBDEs in US milk and blood samples analyzed in recent decades; BDE 47 is an especially dominant congener [1, 4]. We have previously demonstrated high levels of PBDEs in household dust and in computer casing with BDE 209 frequently being a major component [5]. In this paper we compare new Vietnam milk data with US data, and present indoor and outdoor US air PBDE levels. US fast food PBDE levels are described and congener distribution noted. We estimate US adult and infant PBDE intake from food, dust and air.

Materials and Methods:
These have been previously described and will not be reviewed in this paper [6].

Results:
Figure 1 presents our PBDE measurements from 62 US milk samples, with all specimens positive and total PBDEs ranging from 4-400 + ppb [1, 4]. Blood findings are very similar [4]. The positively skewed shape of the distribution is typical for PBDEs in US milk and also blood. Table 1 compares US blood levels of three commonly measured PBDE congeners in the US and other countries. The highest levels measured to date are in the US and the lowest in less industrialized Vietnam, with European levels several orders of magnitude less than US levels. Table 2 provides details of congeners and levels in the US and recently collected (2006) milk from the north and south of Vietnam. The low Vietnamese levels may be similar to PBDE levels in other less industrialized countries. Table 3 illustrates the findings of a decrease in blood levels of dioxins, dibenzofurans and PCBs over two decades in contrast to a marked increase in PBDEs in serum. Table 4 presents US market basket levels of PBDEs in fish, meat and dairy products. The highest levels occur in fish but the greatest dietary intake is from meat due to the larger amount of meat consumed by Americans. Table 5 presents major measured congeners and total PBDE in selected US fast food and ice cream purchased in Dallas, Texas from major popular American food chains or stores. Table 6 demonstrates the effect of broiling with fat dripped from the food; we usually note a decrease in lipid percent and decrease in total PBDEs per serving for each type of food illustrated [7]. Table 7 presents recent PBDE levels from a small sample of indoor and outdoor air in Houston, Texas. As usual, indoor air is higher than outdoor air in PBDE levels. Table 8 presents our most recent calculation of mean PBDE intake of US adults and nursing infants in the general US population from food, dust and air with approximately 1.2 ng/kg/day or 75.4 ng/day in adults and 320 ng/kg/day or 2243 ng/day in nursing infants.

Discussion and Conclusions:
Our findings continue to show that there is contamination with PBDEs in all US milk and blood samples and at levels orders of magnitude above those found in Europe, which in turn are higher than Vietnamese levels. US Food

levels are higher than found in some other countries with fish having highest contamination but highest dietary intake in the USA is from meat. Fast food as well as food from market basket surveys contains PBDEs. The highest intake is found in nursing infants. Air appears to be a minor source of PBDE intake whereas food and dust count for most PBDE body burden.
We are not certain of the exact human health risks from PBDEs but since they are similar to PCBs in structure and found to be toxic in some animal studies, there appears to be a public health need to decrease levels in the environment.

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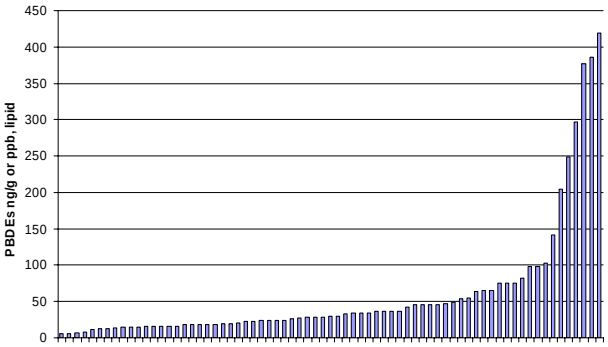
Figure 1: U.S. Human milk PBDE levels, 2005, N=62
ng/g or ppb, lipid
Mean: 66 ppb, median: 32 ppb, minimum: 6.2 ppb, maximum: 418 ppb



Schecter A. EHP (2003), 111 (14):1723-1729 and Schecter A. et al. JOEM (2005), 47(3):199-211

Table 1: Median levels of PBDE 47, 99, 153 in human milk from different countries ng/g (ppb) lipid

	USA EWG 2003 (n=20)	USA Texas 2005 (n=62)	Canada 2002 (n=92)	Canada 1992 (n=72)	Germany 2000 (n=7)	Sweden 2000 (n=40)	Finland 1994-98 (n=11)	Hanoi Vietnam 2004 (n=2)
BDE 47	25	17	13	1.4	0.8	1.7	1.0	2.0
BDE 99	4.5	5.1	3.0	0.5	0.2	0.2	0.4	0.06
BDE 153	10.1	2.1	1.3	0.3	0.5	0.5	0.3	0.09

Schecter A. et al. EHP (2003), 111(14):1723-1729 and Schecter et al. JOEM (2005)

Table 2: Median levels of PBDEs in US and Vietnamese Human Milk ng/g (ppb) lipid USA (n=62, 2005) and Vietnam (n=10, 2006)

	BDE 47	BDE 99	BDE 100	BDE 153	BDE 154	BDE 183	BDE 209	Total PBDEs without 209	Total PBDEs with 209
USA	17	5.1	2.7	2.1	0.22	0.09	2.4	30.4	31.9
VIETNAM	0.12	0.02	0.05	0.16	0.02	0.02	0.24	0.46	0.80

Table 3: Mean US serum levels of dioxins, dibenzofurans, PCBs and PBDEs, 1973 and 2003 pg/g or ppt lipid

Year	Dioxins	Dibenzofurans	Coplanar PCBs	Mono–ortho PCBs	PBDEs
1973	3,980	122	807	210,675	700
2003	450	34	58	26,370	62,000

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Table 4: Market basket survey of PBDEs in US food and daily adult dietary intake

	Sum PBDEs Median (ppt, ww)	Daily dietary intake of PBDE in adult (pg/kg bw/day)
Fish N=24	616	85
Meat N=18	190	587
Dairy N=15	32.2	89

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Table 5: Selected PBDE congeners in US fast food
(Median) pg/g (ppt), ww

	Mc Donald's Big Mac	Mc Donald's French Fries small size	Mc Donald's Mc Chicken Sandwich	Mc Donald's Filet O' Fish Sandwich	Wendy's Hamburger	Taco Bell soft Tacos (beef)	Pizza Hut Personal Pan Pizza supreme	Häagan-Dazs Butter Pecan Ice Cream	Burger King Veggie Burger
Sample Weight (g)	9.628	10.045	10.256	10.135	10.702	11.051	10.012	6.369	10.528
Lipid Content (%)	13.85	17.93	9.35	13.19	12.04	9.16	11.84	20.16	7.01
BDE #47	15.27	11.41	15.4	9.17	26.53	19.48	39.5	32.47	9.81
BDE #99	15.47	16.9	10.8	11.5	18.38	16.43	47.36	18.16	6.03
BDE #100	2.75	3.45	2.1	2.07	3.14	2.76	7.6	3.75	1.26
BDE #153	4.2	0.9	2.6	2.74	4.67	3.36	3.88	3.18	0.35
BDE #154	3.08	0.9	2.1	2.23	3.48	2.26	3.9	2.57	0.35
Total BDE	40.79	33.56	33	27.71	56.2	44.27	102	60.13	17.52

Table 6: Effect of cooking:
Lipid and PBDE level changes per portion (mean)

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	272.2	259.0
Salmon	12.3	7.8	132.7	115.5

After Schecter A. et al. J Tox Environ Chem. (2006), 88(2):207-211

Table 7: Median PBDE Levels in Houston, Texas, US Air

PBDE Conc. (pg/m3)		
Outdoor	Car	Indoor
126	283	580

Table 8: Total mean PBDE intake in the U.S. general population

Age Group (Years)	Source			Total ng/kg/day	Total ng/day
	Food ng/kg/day	Dust ng/kg/day	Air ng/kg/day		
Adults (19-65+)	1.0	0.04	0.11	1.2	75.4
Nursing Infants (<1)	306	13	0.34	320	2243