



Mixed halogenated dioxins in breast milk of first time mothers in Ireland

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Breast milk as a bio-monitor of body burden of POPs

- Milk fat in equilibrium with fat reserves of body
- Non-invasive method of monitoring body burden
- Reflection of the previous (lifetime) exposure of the mother to POPs



Breast milk as a bio-monitor of body burden of POPs

- 2nd POPs study in human breast milk in Ireland (first study conducted in 2002 on PCDD/Fs and PCBs only)
- Multi-POP Analysis covering wide range of analytes*
- Following WHO guidelines

*Pratt IS, Anderson WA, Crowley D, Daly SF, Evans RI, Fernandes AR, Fitzgerald M, Geary MP, Keane DP, Malisch R, McBride J, Morrison JJ, Reilly A, Tlustos C. (2012) Polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) in breast milk of first-time Irish mothers: impact of the 2008 dioxin incident in Ireland. *Chemosphere*. 2012 Aug;88(7):865-72.

*Pratt I, Anderson W, Crowley D, Daly S, Evans R, Fernandes A, Fitzgerald M, Geary M, Keane D, Morrison JJ, Reilly A, Tlustos C. (2013) Brominated and fluorinated organic pollutants in the breast milk of first-time Irish mothers: is there a relationship to levels in food? *Food Addit Contam Part A Chem Anal Control Expo Risk Assess*. 2013;30(10):1788-98.

Sample Characteristics

Recruitment of mothers during post natal period

- Three Dublin centres, one Galway during 2009/10

Following WHO protocol (as far as possible)

- Continuous residence in area at least 5 years
- Age < 30 years
- First-time mothers
- Exclusively breast feeding

Additional information collected

- Country of birth
- Demographic data including age, weight, height
- Food Frequency Questionnaire ("model questionnaire for donors")



Sample Characteristics

- 109 mothers in total
- 11 pools (7-11 mothers)
- Age 20 – 41 years
- Mean BMI 23.3
- 0 – 40% of mothers in each pool born outside Ireland



Sample Characteristics

Pool ID	County	No of mothers	Born outside IRL	Age mean (range)	BMI mean (range)
Pool 1	Dublin	10	1-2	33.6 (26–41)	27.7 (18.4–38.9)
Pool 2	Galway	10	1-2	32.3 (20–39)	21.8 (15.8–25.7)
Pool 3	Galway	10	0	31.8 (27–36)	22.8 (19.8–28.0)
Pool 4	Galway	10	0	32.7 (27–37)	22.8 (20.3–26.6)
Pool 5	Dublin	11	1-2	32.5 (23–39)	22.5 (18.1–27.2)
Pool 6	Dublin	11	1-2	32.5 (30–40)	23.3 (19.1–34.8)
Pool 7	Dublin	10	1-2	30.2 (23–37)	24.1 (17.5–34.6)
Pool 8	Dublin	10	0	34.2 (30–38)	22.1 (17.9–24.9)
Pool 9	Dublin	10	4	33.2 (30–35)	23.0 (18.1–30.4)
Pool 10	Dublin	10	0	32.4 (27–40)	23.3 (19.7–27.1)
Pool 11	Dublin	7	3	34.7 (30–41)	23.0 (20.6–28.7)



Mixed halogenated dioxins

Possible congeners:

1,550 dioxins

3,050 furans

With 2,3,7,8 substituents:

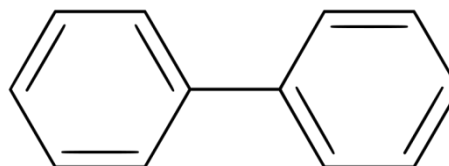
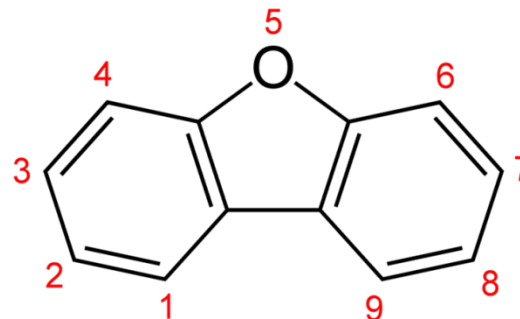
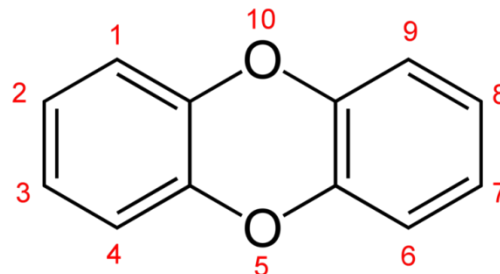
337 dioxins

647 furans

2,3,7,8-tetra: 13 congeners

2,3,7,8-penta: 90 congeners

9,180 biphenyls



PXDD/F and PXB analytes selected for measurement

Analyte	Configuration	Halogenation
Dioxins	2-Br-7,8-Cl-DD	Tri
	2-Br-3,7,8-Cl-DD	Tetra
	2,3-Br-7,8-Cl-DD	Tetra
	1-Br-2,3,7,8-Cl-DD	Penta
	2-Br-1,3,7,8-Cl-DD	Penta
	2-Br-3,6,7,8,9-Cl-DD	Hexa
Furans	2-Br-7,8-Cl-DF	Tri
	2-Br-6,7,8-Cl-DF	Tetra
	3-Br-2,7,8-Cl-DF	Tetra
	2,3-Br-7,8-Cl-DF	Tetra
	1-Br-2,3,7,8-Cl-DF	Penta
	4-Br-2,3,7,8-Cl-DF	Penta
	1,3-Br-2,7,8-Cl-DF	Penta
Biphenyls	4'-Br-3,3',4,5-Cl-B	Penta
	3,4-Br-3',4',5'-Cl-B	Penta
	3',4',5-Br-3,4-Cl-B	Penta
	4'-Br-2,3',4,5-Cl-B	Penta
	4'-Br-2,3,3',4,-Cl-B	Penta
	4'-Br-2,3,3',4,5-Cl-B	Hexa

How much is captured?

Congener group	Number measured	Total possible '2,3,7,8'	Percentage measured
2,3,7,8-TXDD	2	5	40%
1,2,3,7,8-PeXDD	2	30	7%
2,3,7,8-TXDF	2	8	25%
1,2,3,7,8-PeXDF	2	30	7%
2,3,4,7,8-PeXDF	1	30	3%
PXB 126	3	18	17%



Method of Analysis

A.R. Fernandes et al. / J. Chromatogr. A 1218 (2011) 9279–9287

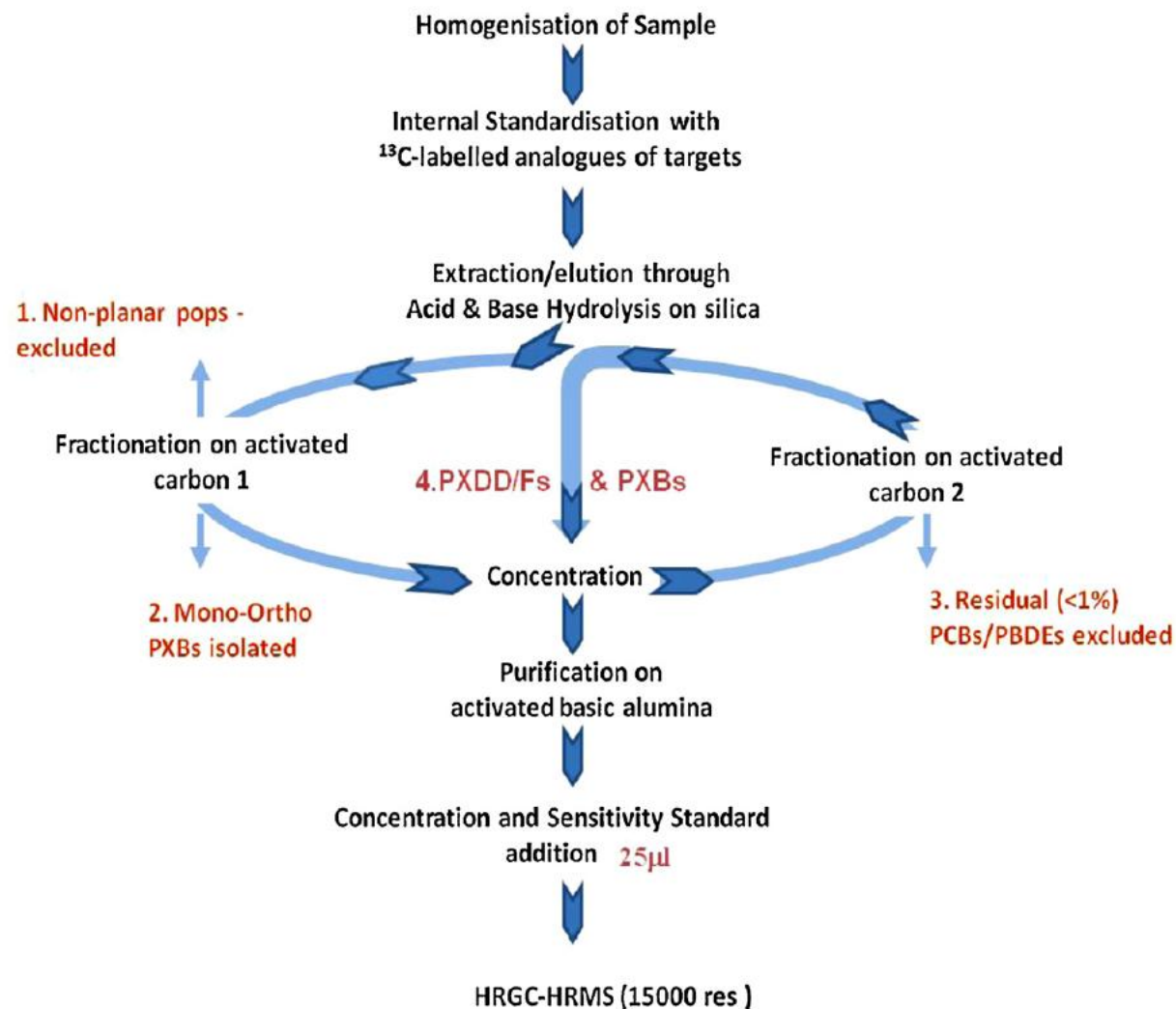


Fig. 1. Methodology schematic showing dual carbon column fractionation.



Results

Fat Content - Mean 2.9 %

Fat Content - Range: 2.4 - 3.4 %



Results

	Pool 1	Pool 2	Pool 3	Pool 4	Pool 5	Pool 6	Pool 7	Pool 8	Pool 9	Pool 10	Pool 11
% Fat	2.9	3.4	2.6	2.8	3	2.4	2.7	3.2	2.9	3.2	3
PXDD/Fs ng/kg fat weight											
2-B-7,8-CDD	<0.014	0.027	0.017	<0.014	0.015	<0.013	<0.015	<0.009	<0.014	<0.011	<0.02
2-B-3,7,8-CDD	0.078	0.055	0.024	0.043	0.034	0.021	<0.02	0.032	<0.019	<0.015	0.055
2,3-B-7,8-CDD	<0.025	<0.019	<0.022	0.025	<0.017	<0.023	<0.025	<0.015	<0.024	<0.02	0.012
1-B-2,3,7,8-CDD	<0.011	<0.008	<0.01	<0.011	<0.008	<0.01	<0.011	<0.007	<0.011	<0.009	<0.015
2-B-1,3,7,8-CDD	<0.016	<0.012	<0.015	<0.016	<0.012	<0.015	<0.017	<0.01	<0.016	<0.013	<0.018
2-B-3,6,7,8,9-CDD	<0.015	0.031	<0.014	0.045	<0.011	<0.014	<0.016	<0.009	<0.015	<0.012	<0.049
2-B-7,8-CDF	<0.022	0.037	<0.02	<0.021	<0.015	<0.025	<0.023	<0.014	<0.021	<0.017	<0.017
3-B-2,7,8-CDF	<0.018	<0.014	<0.017	<0.018	<0.013	<0.017	<0.019	<0.012	<0.018	<0.015	<0.019
2-B-6,7,8-CDF	<0.017	<0.013	<0.015	<0.017	<0.012	<0.016	<0.018	<0.011	<0.017	<0.014	<0.011
2,3-B-7,8-CDF	0.017	0.022	0.018	<0.015	0.013	<0.014	<0.016	0.021	<0.015	<0.012	<0.021
1-B-2,3,7,8-CDF	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
4-B-2,3,7,8-CDF	0.129	0.101i	0.114	0.041i	0.096i	0.058	0.051i	0.058	0.082	0.058	0.11i
1,3-B-2,7,8-CDF	0.027	<0.005	<0.006	<0.007	<0.005	<0.006	<0.007	<0.005	<0.007	<0.005	<0.014
PXBs ng/kg fat											
4'-B-3,3',4,5-CB (PXB126)	0.223	0.125	0.137	0.15	0.114	0.113	0.091	0.12	0.118	0.141	0.127
3,4-B-3',4',5'-CB (PXB126 di-Br)	0.127	0.069	0.114	0.075	0.102	0.09	0.044	0.115	0.09	0.04	0.147
3',4',5'-B-3,4-CB (PXB126 tri-Br)	0.072	0.114	0.066	0.057	0.065	0.04i	0.041	0.085	0.045	<0.019	0.034
4'-B-2,3',4,5-CB (PXB 118)	0.581	0.453	0.409	0.562i	0.464	0.638	0.352	0.411	0.681	0.375	1.066
4'-B-2,3,3',4-CB (PXB 105)	0.431	0.364	0.276	0.267	0.3	0.15	0.095i	0.165	0.412	0.263	0.92
4'-B-2,3,3',4,5-CB (PXB 156)	0.43	0.365	0.322	0.21	0.367	0.251	0.217	0.176	0.542	0.308	0.925

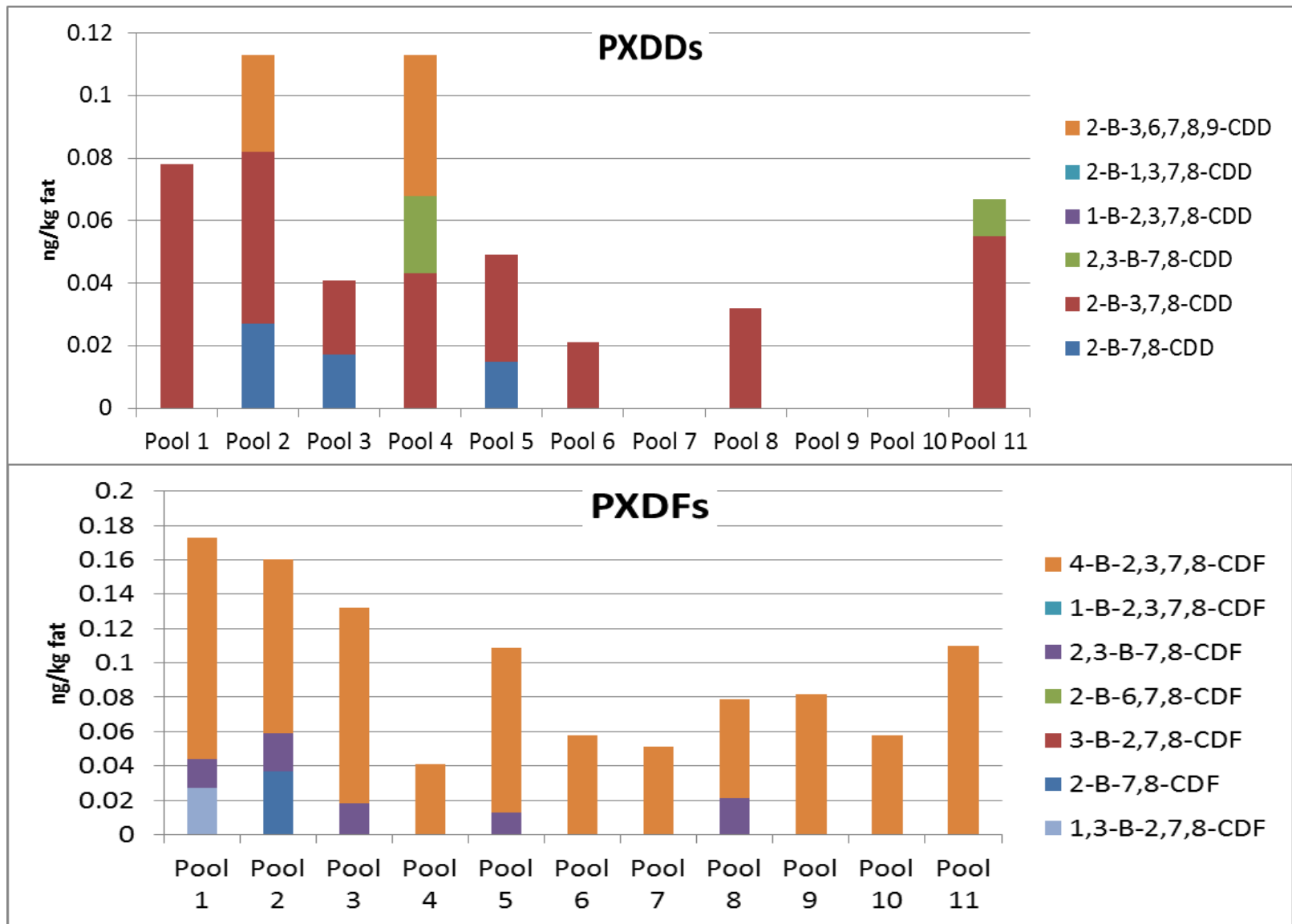


Results > LOD

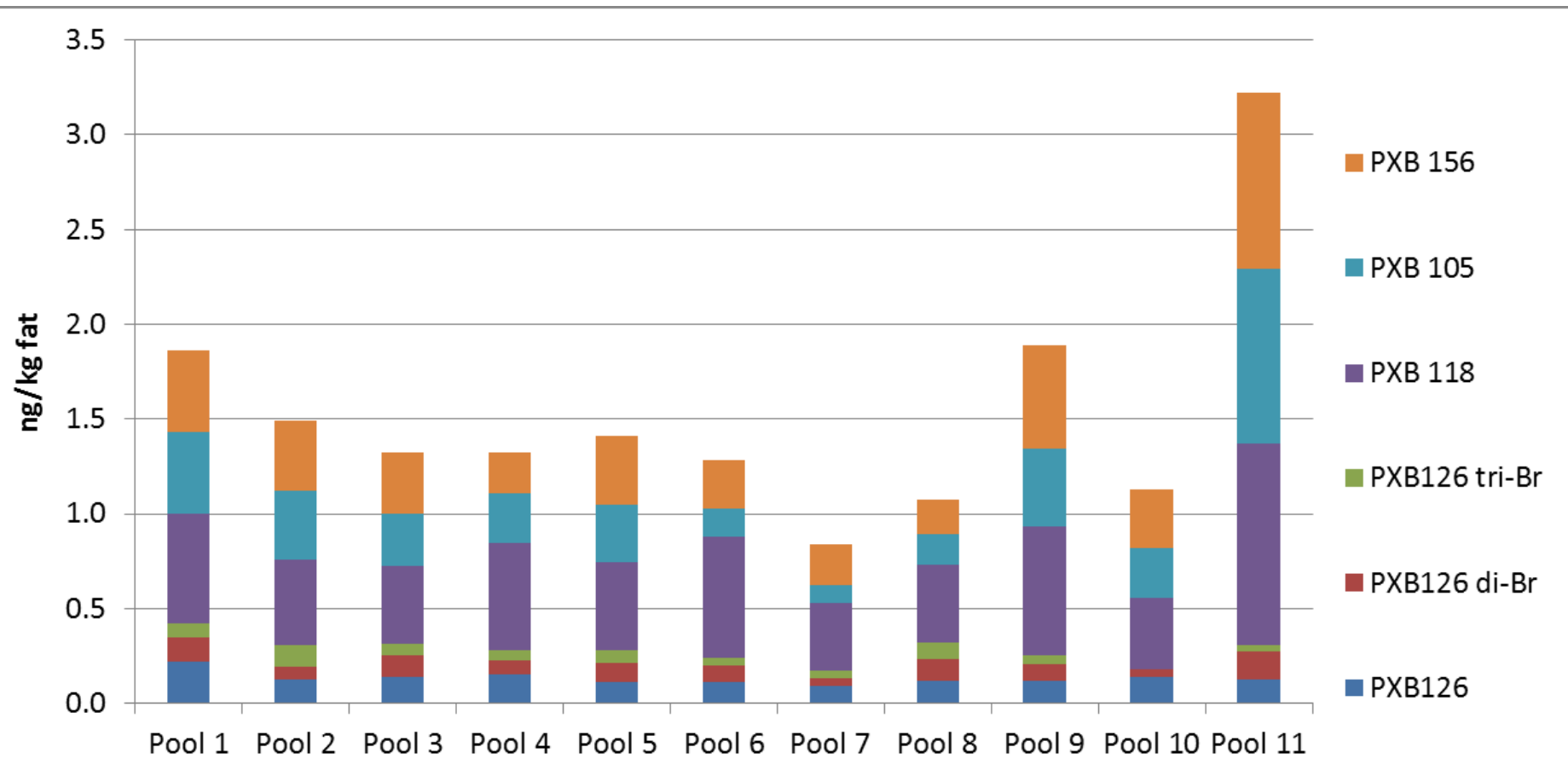
	Pool 1	Pool 2	Pool 3	Pool 4	Pool 5	Pool 6	Pool 7	Pool 8	Pool 9	Pool 10	Pool 11
% Fat	2.9	3.4	2.6	2.8	3	2.4	2.7	3.2	2.9	3.2	3
PXDD/Fs ng/kg fat weight											
2-B-7,8-CDD		0.03	0.02		0.02						
2-B-3,7,8-CDD	0.08	0.06	0.02	0.04	0.03	0.02		0.03			0.055
2,3-B-7,8-CDD				0.03							0.012
1-B-2,3,7,8-CDD											
2-B-1,3,7,8-CDD											
2-B-3,6,7,8,9-CDD		0.03		0.05							
2-B-7,8-CDF		0.04									
3-B-2,7,8-CDF											
2-B-6,7,8-CDF											
2,3-B-7,8-CDF	0.02	0.02	0.02		0.01			0.02			
1-B-2,3,7,8-CDF											
4-B-2,3,7,8-CDF	0.13	0.1	0.11	0.04	0.1	0.06	0.05	0.06	0.08	0.058	0.11
1,3-B-2,7,8-CDF	0.03										
PXBs ng/kg fat											
4'-B-3,3',4,5-CB (PXB126)	0.22	0.13	0.14	0.15	0.11	0.11	0.09	0.12	0.12	0.14	0.13
3,4-B-3',4',5'-CB (PXB126 di-Br)	0.13	0.07	0.11	0.08	0.10	0.09	0.04	0.12	0.09	0.04	0.15
3',4',5'-B-3,4-CB (PXB126 tri-Br)	0.07	0.11	0.07	0.06	0.07	0.04	0.04	0.09	0.05		0.03
4'-B-2,3',4,5-CB (PXB 118)	0.58	0.45	0.41	0.56	0.46	0.64	0.35	0.41	0.68	0.38	1.07
4'-B-2,3,3',4-CB (PXB 105)	0.43	0.36	0.28	0.27	0.30	0.15	0.10	0.17	0.41	0.26	0.92
4'-B-2,3,3',4,5-CB (PXB 156)	0.43	0.37	0.32	0.21	0.37	0.25	0.22	0.18	0.54	0.31	0.93



Results – PXDD/Fs > LOD



Results – PXBs > LOD



Results – Comparison with PCDD/Fs & PBDD/Fs (Range across 11 pools) ng/kg fat

PCDD/F	Range	PBDD/Fs	Range	PXDD/Fs	Range
		2,3,7,-TriBDD	<0.03-0.22	2-B-7,8-CDD	<0.01-0.03
2,3,7,8-TCDD	0.5-0.98	2,3,7,8-TBDD	0.07-0.17	2-B-3,7,8-CDD	<0.02-0.08
				2,3-B-7,8-CDD	<0.01-0.03
1,2,3,7,8-PeCDD	1.3-2.5	1,2,3,7,8-PeBDD	<0.04-<0.11	1-B-2,3,7,8-CDD	<0.01-<0.02
				2-B-1,3,7,8-CDD	<0.01-<0.02
1,2,3,4,7,8-HxCDD	0.54-1.28	1,2,3,4,7,8/ 1,2,3,6,7,8-HxBDD	<0.08-<0.1	2-B-3,6,7,8,9-CDD	<0.01-0.05
1,2,3,6,7,8-HxCDD	2.8-6.9				
1,2,3,7,8,9-HxCDD	0.68-1.51	1,2,3,7,8,9-HxBDD	<0.08-<0.1		
		2,3,8-TriBDF	<0.03-0.08	2-B-7,8-CDF	<0.01-0.04
2,3,7,8-TCDF	0.34-0.85	2,3,7,8-TBDF	0.72-1.46	3-B-2,7,8-CDF	<0.01-<0.02
				2-B-6,7,8-CDF	<0.01-<0.02
				2,3-B-7,8-CDF	<0.01-0.02
1,2,3,7,8-PeCDF	0.16-0.82	1,2,3,7,8-PeBDF	0.24-0.69	1-B-2,3,7,8-CDF	<0.005-<0.01
2,3,4,7,8-PeCDF	3.7-7.1	2,3,4,7,8-PeBDF	0.5-1.41	4-B-2,3,7,8-CDF	0.04-0.13
				1,3-B-2,7,8-CDF	<0.005-0.027



Results – Comparison with PCBs/PBBs (Range across 11 pools) ng/kg fat

PCBs	Range	PBBs	Range	PXBs	Range
PCB77	2-5.9	PBB-77	<0.11-0.14		
PCB126	17.1-33.2	PBB-126	0.2-0.4	PXB126	0.09-0.22
				PXB126 di-Br	0.04-0.15
				PXB126 tri-Br	<0.02-0.11
PCB105	0.66-1.47			PXB 105	0.1-0.92
PCB118	3.2-6.2			PXB 118	0.35-1.07
PCB156	1.1-2.5			PXB 156	0.18-0.93



Conclusion

- PXDD/Fs & PXBs detected in human breast milk
- PXBs > Furans > Dioxins
- Only fraction of all potentially present congeners analysed
- Incremental addition to 'characterised' Ah-Receptor activation
- Currently not possible to estimate extent of contribution





Thank you for your attention

