The impact of industrial dioxin reservoir on biota and population

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Introduction

There are few places of high dioxin pollution caused by industrial production, accidents and application of dioxin-containing phenoxyherbicides left in the world. At present the highest TCDD levels are found and registered in soil samples (more than 1 ppm TCDD)[1], biota (up to 15.3 ppb TCDD in fish)[2] and in human tissues (over 400 ppt TCDD)[3] in Vietnam.

In Ufa (capital of the Republic of Bashkortostan) PCDD/Fs pollution is high[4,5]. The pollution is a result of emissions from chlororganic waste incinerators and from a chemical plant (Khimprom) that produced 2,4,5-T during the 1960s, trichlorphenol until the late 80s and chlorine and some herbicides up to 2005. The most highly polluted area is the waste disposal site that is situated outside the plant territory. This site allowed large amounts of TCDD into the environment (over 130 ppb TCDD in soil)[6]. The hot spot of extreme pollution around Khimprom is similar to local pollution in Vietnam (Bien Hoa) formed as a result of storing Agent Orange[2]. The aim of this paper is to show the results of high industrial pollution in Ufa that can be compared with the dioxin hot spot found in Vietnam.

Methods and Materials

Soil, silt and sludge were sampled in 1998-2004. Worms (*Lumbricus terrestris*) and frogs (*Rana ridibunda*) found in the pond formed by ground waters from the toxic waste disposal site of Khimprom served as biomarkers. Fish (sterlet, *Acipenser ruthenus*) was caught in the river close to the plant, wild duck (*Anas platyrhychos*) was caught 5 km away from the plant. Samples of breast milk, fat tissue and blood were taken from Ufa citizens living at a distance of less than 5-7 km from the polluted zone. Pooled samples were not used. In most samples PCDD/Fs and PCBs-WHO were determined. Methods of PCDD/Fs/PCBs determination in serum[7], soil and waste[8] were described earlier.

Results and Discussion

Monitoring of polluted area in Ufa revealed the whole specter of PCDD/Fs/PCBs the concentration of which is reaching 200 ppb TEQ. PCDD/Fs content in biota samples is comparable with the data of Bien Hoa, Vietnam[3] (Table 1). The main input is made by 2,3,7,8-TCDD (up to 95%). PCDD/Fs in fish caught in the river where bottom sediment is polluted by waste and contaminated ground waters reaches 306.3 pg/g TEQ. This value by 3.5 times exceeds the admissible concentration according to Russian standards (88 pg/g of lipids) and is dangerous for recereational fishermen who are using it for food though fishery in this river has no commercial significance. In tissue of a wild duck that could feed itself on polluted ponds 14.4 pg/g lipids TEQ PCDD/Fs (4.1 pg/g 2378-TCDD, 5.7 pg/g PnCDD) and 7.8 TEQ PCBs were determined.

The higher risk zone (3 km away from the plant) is inhabited by 2500 people while within 7 km there are over 300000 people. Dioxin concentration in breast milk, blood and fat tissue of donors from this area are given in Table 2. Increased PCDD/Fs level for inhabitants of the industrial zone confirm the high background level for the city in the whole. It was reported earlier[9,10] that the level of cotaminantion is 30% greater than that of the whole of Russia and of other countries. The present study reveals the influence of the proximity to the chemical plant (the source of PCDD/Fs emission) on contaminant load and confirms the dependence of contaminant load - age relationship shown in many papers. Figure 1 presents the distribution TEQ PCDD/Fs versus age for inhabitants of the district with increased pollution in Ufa. Data of most representative study of this kind carried out for the population of the USA are given for comparison[11].

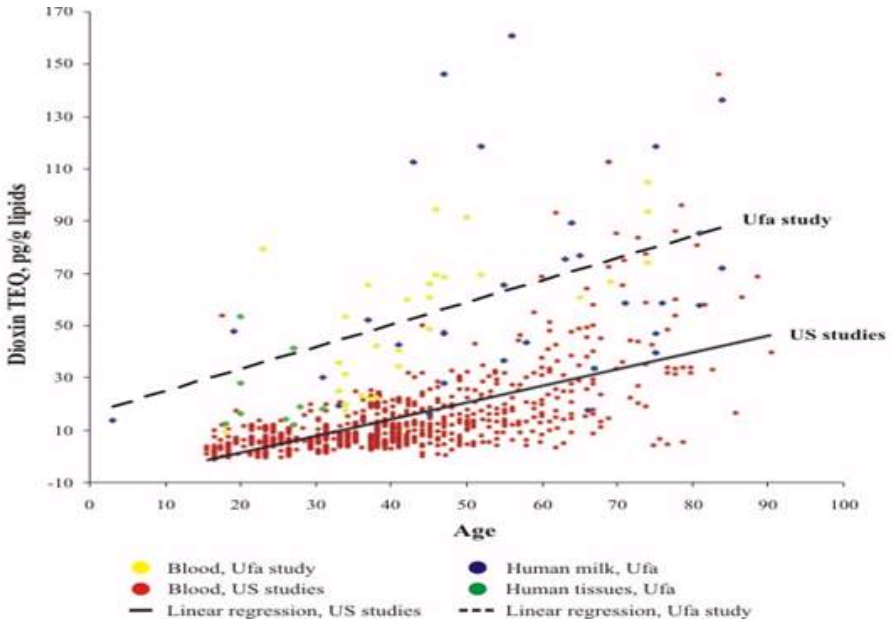

Figure 1. TEQ PCDD/Fs in blood, fat and milk samples from polluted zone from Ufa in comparison with the data for population of 4 states of USA.

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Table 1 . **PCDD/Fs and PCBs in biota and soil from high pollution zone (mean)**

PCDD/Fs	**Slit**	**Soil**	**Fish**	**Worm**	**Frog**	**Toad**
Number of samples	9	12	3	10	5	Bien Hoa[2*]
Units	pg/g d.w.	pg/g d.w.	pg/g l.b.	pg/g l.b.	pg/g l.b.	pg/g l.b.
2378-TCDD	22952.7	6511.2	132.8	20607	***10933***	***8235.3***
12378-PnCDD	11490.1	2683.1	40.2	10000	***654***	***1367.6***
123478-HxCDD	1313.9	527.9	2.9	512	***44***	***1382.4***
123678-HxCDD	5929.4	1679.3	1.9	1515	***116***	***5735.3***
123789-HxCDD	2894.4	912.4	3.3	2157	***36***	***235.3***
1234678-HpCDD	13834.5	4241.0	11.6	2988	***116***	***2794.1***
OCDD	202363.7	57964.5	15.5	92190	***736***	***1911.8***
2378-TCDF	1735.5	677.8	576.9	5000	***230***	***12.2***
12378-PnCDF	2165.1	679.1	86.7	6717	***101***	***25.0***
23478-PnCDF	4628.5	1406.4	130.5	3283	***627***	***764.7***
123478-HxCDF	6093.1	2366.7	5.0	2828	***172***	***1294.1***
123678-HxCDF	3871.2	1259.4	14.12	1475	***98***	***308.8***
123789-HxCDF	1477.2	518.5	15.14	308	***ND (6)***	***16.2***
234678-HxCDF	2032.2	674.1	6.6	5389	***133***	***133.8***
1234689-HpCDF	46259.7	12944.5	3.15	22777	***42***	***91.2***
1234789-HpCDF	ND(13)	16.3	12.0	ND(18)	***ND(12)***	***13.1***
OCDF	ND(10)	6.7	6.23	ND(2)	***ND(9)***	***39.7***
PCB 77	2240.9	1217,7	8702.4			***441.2***
PCB 81	831.5	423.9	1066.3			***308.8***
PCB 105	34661	22440.7	168597			***7500.0***
PCB 114	3696.8	2479.7	14439.7			***970.6***
PCB 118	43223.6	19836.6	347341.4			***45588.2***
PCB 123	ND(6)	1.9	5766.3			***NA***
PCB 126	318.8	166.2	793.2			***4852.9***
PCB 156	9088.7	4678.2	30778.6			***591617.6***
PCB 157	2109.6	1448.9	6750.3			***147794.1***
PCB 167	3176.7	2138.7	14171.8			***43382.4***
PCB 169	ND(1)	0.3	156.85			***90735.3***
PCB189	651.4	486.5	1157.3			***21470.6***
TEQ PCCD/Fs	**196203**	**10869.2**	**306.4**	**23680**	***11714***	***10882.4***
TEQ n-ortho PCB	**32.2**	**16.9**	**81.9**			***764.7***
TEQ m-ortho	**15.3**	**8.5**	**79.4**			***161.8***
SUM TEQ	**196250**	**10894.6**	**466.6**			***11764.7***

*- Data given in the paper of Schecter A. et al . [2]have been re-calculated for the lipids based.

Table 2. PCDD/Fs/PCBs in tissues of inhabitants from the pollution zone, Ufa

PCDD/Fs/PCBs	Breast milk		Blood/serum		Human tissue	
Number of samples	5		29		28	
Age	19-24		33-74		3-81	
pg/g lipid based	mean	med	mean	med	mean	med
2378-TCDD	12.7	8.7	17.4	16.8	28.8	22.7
12378-PnCDD	14.3	13.2	18.1	15.6	26.4	24.7
123478-HxCDD	1.3	0.9	8.4	6.9	4.9	2.9
123678-HxCDD	4.3	3.3	18.3	13.6	5.7	5.7
123789-HxCDD	1.3	1.1	6.5	5.5	1.6	0.8
1234678-HpCDD	7.0	7.6	29.6	17.1	11.2	10.7
OCDD	17.5	15.5	203.0	157.4	54.7	42.9
2378-TCDF	2.1	1.8	4.7	3.8	3.5	2.6
12378-PnCDF	0.6	0.6	5.4	4.7	1.7	0.9
23478-PnCDF	6.0	5.2	16.6	16.2	18.1	17.5
123478-HxCDF	2.5	1.7	6.3	5.9	4.8	4.5
123678-HxCDF	3.1	3.6	9.0	7.5	6.4	6.0
123789-HxCDF	0.8	0.9	5.0	5.1	0.9	0.5
234678-HxCDF	2.1	1.5	3.5	4.2	1.6	1.3
1234689-HpCDF	4.3	4.5	12.7	9.5	3.8	3.2
1234789-HpCDF	0.8	0.7	4.5	4.4	1.9	1.6
OCDF	1.1	0.5	2.2	0.3	1.7	0.8
PCB 77	32.7	27.4	62.8	72.4	264.5	109.1
PCB 81	40.5	42.9	82.3	72.4	27.9	24.2
PCB 126	95.6	106.9	79.2	52.1	195.2	138.2
PCB 169	17.0	17.7	26.7	29.2	58.5	50.3
PCB 105	8607.8	6609.4	20396.4	11496.2	22966.7	18358.9
PCB 114	1482.6	1366.4	3200.6	2181.5	10468.9	6765.7
PCB 118	23347.2	22362.3	65760.7	39697.3	81285.7	72702.6
PCB 123	461.0	419.5	1234.8	895.4	1525.7	1150.1
PCB 156	15125.7	6663.2	13259.6	11857.2	36281.1	36929.4
PCB 157	1502.4	1373.5	3428.9	3008.6	7273.9	7245.9
PCB 167	1279.7	1103.4	3506.2	2725.5	7376.1	6325.7
PCB 189	206.3	176.9	805.8	661.9	1615.4	1410.8
TEQ PCDD/Fs	**30.4**	**28.1**	**54.8**	**60.0**	**62.5**	**58.1**
TEQ n-ortho PCB	**9.7**	**5.2**	**10.3**	**0.6**	**23.6**	**16.4**
TEQ m-ortho	**12.4**	**12.6**	**18.8**	**13.5**	**40.2**	**37.8**
SUM TEQ	**52.5**	**47.0**	**84.0**	**74.1**	**127.0**	**110.1**