

PCDD/Fs Levels in Blood and Human Milk from Urban and Rural Areas Of Bashkortostan, Russia

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Introduction

Determination of PCDD/Fs background levels in human biological tissue serves as a rather reliable marker of technologies exposure and a basis for assessment of carcinogenic risk caused by PCDD/Fs. In [1] we have already reported on background levels in blood, breast milk and fat for the population of Ufa. There was a period of PCDD/Fs pollution of the chemical plant area in the history of the city (2,4,5-T production). This paper presents a similar research for other cities and rural areas of this region.

The region area is 14.3 million hectares. About half of the area are agricultural lands. Among the examined cities there are industrial centres with plants of oil chemistry, basic organic synthesis (Sterlitamak, Salavat), metallurgy (Kumertau, Beloretsk) and small towns with no industrial load. In addition to our data for Ufa in 1996 analysis of breast milk taken from women of Salavat was carried out by Liem within the frame of the project "Analysis of breast milk in Russia" [2]. The results revealed a mean level of PCDD/Fs pollution – 16 pg/g of lipids in milk. Rural areas of the region had a different level of pesticide load due to the application of the herbicide 2,4-D in which PCDD/Fs traces had been registered [3].

Objects and Methods

During 1998 pool and individual samples of blood and breast milk were taken from permanent residents of cities and villages. Donors' age, diet peculiarities, probability of occupational exposure was specified. 50 samples of breast milk and 22 samples of blood from 12 cities and 10 districts were analysed. The volume of individual samples was 50 ml for blood and 100 ml for milk.

Before analysing the samples had been stored in a frozen state (minus 20°C). PCDD/Fs determination was carried out in compliance with the Methods of HRGC/HRMS (EPA 1613). Samples preparation had been described earlier [2]. Breast milk samples were extracted by a mixture of hexane - acetone, blood samples were extracted by a mixture of hexane - ethanol - sulphuric ether. Toxicity indexes were calculated according to the scale of I-TEF. The calculation was made for lipid fraction of blood and breast milk.

Results and Discussion

Isomer composition of breast milk samples of donors and mean values for cities and villages of the region are given in Table 1, 2. As Table 1 shows the most polluted breast milk samples are from Ufa and from neighbouring (about 100 km) Blagoveshchensk (25.9-27.1 pg TEQ/g). This is most probably due to transfer of pollution from chemical plants to the city. Meteorological conditions and lay out of freight transportation roads also contribute to pollution. Increased PCDD/Fs level in milk samples from Iglinsky and Sterlitamaksky (21.9 and 26.7 pg TEQ/g) districts are accounted for by their location in the vicinity of industrial centres.

Breast milk sample from Salavat contained 8.7 pg/g of lipids what is lower than the value earlier reported [2]. Perhaps individual differences were of importance or some peculiarities of sampling. Probably pollution of population is being reduced (in our opinion data on time trend of PCDD/Fs in breast milk are so far insufficient).

Results of blood samples analyses mainly correspond to the data on PCDD/F contents in breast milk from the same districts. Pollution level in industrial centres is by 10-15% higher than that in rural areas due to technologies load. However only samples from Ufa and Blagoveshchensk have an increased 2,3,7,8-TCDD level as a result of pollution by the chemical plant producing 2,4,5-T. Samples from small towns do not carry any information on technologies pollution. It is obvious that individual qualities or diet peculiarities acquire more importance (Tables 3, 4).

Mean level of pollution does not exceed similar levels for other regions of the world. Analysis of PCDD/Fs accumulation in individual samples from donors of different age permits to estimate accumulation in biological human tissues at the level of 0.8 pg per year for cities and 0.5 pg per year for rural areas).

Table 2. PCDD/Fs in breast milk, pg/g lipids

PCDD/Fs	Mean of cities, n=8	Mean of rural areas, n=9	Region
2,3,7,8-TCDD	7.0±6.5	4.6±4.9	5.7±7.2
TEQ	15.91±11.2	12.8±11.9	14.4±12.2
Number of donors	43	23	66

Table 4. PCDD/Fs in whole blood, pg/g lipids

PCDD/Fs	Industrial centres, n=4	Small towns, n=7	Rural areas, n=12	Region
2,3,7,8-TCDD	14.3±7.5	5.9±4.9	5.5±4.9	8.6±4.1
TEQ	39.8±10.2	25.0±15.3	24.8±7.5	29.9±13.9
Number of donors	124	138	102	264

References

1. Amirova Z, Kruglov E, Loshkina E, Chalilov R; Organohal. Comp. 1998, 38, 105
2. Traag W, Yufit S; Organohal. Comp. 1997, 33, 473
3. Schecter A et.al; Organohal. Comp. 1997, 32, 51

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Table 1.

PCDD/F contents in breast milk of citizens, Bashkortostan

PCDD/Fs	Cities									Rural areas										
	Ufa	Blagoveshensk	Davlecanovo	Ishimbay	Kumertau	Neftecamsk	Salavat	Yanaul	Mean of cities	Baimaksky	Beloretcky	Iglinsky	Mechetlinsky	Mishkinsky	Salavatsky	Sterlitamaksky	Checmagushevsky	Ishimbaysky	Mean by areas	Mean (region)
378-TCDD	13.5	13.6	3.5	9.4	3.8	5.3	2.9	3.6	7.0	1.6	2.4	9.3	2.0	3.9	3.1	10.6	4.8	4.0	4.6	5.7
378-PnCDD	11.1	14.1	4.1	0.2	3.8	5.0	2.8	3.6	5.6	1.9	1.6	11.0	2.9	3.4	3.3	10.9	5.2	5.2	5.0	5.3
478-HxCDD	2.8	2.2	1.8	1.2	1.0	1.6	0.7	1.1	1.5	0.4	0.5	1.9	0.7	1.2	0.8	1.0	1.3	0.9	1.0	1.3
678-HxCDD	6.7	3.6	1.9	1.6	2.4	3.2	3.0	2.7	3.1	1.1	0.8	4.1	1.0	2.1	2.3	4.3	2.8	2.6	2.4	2.8
789-HxCDD	2.1	0.6	0.4	0.3	0.8	0.7	2.1	0.9	1.0	0.3	0.6	0.9	0.4	0.7	1.7	3.7	0.4	0.5	0.9	0.9
4678-HpCDD	10.7	3.6	2.6	3.1	3.1	5.4	6.7	3.5	4.8	2.1	2.7	4.1	3.2	3.2	1.9	8.0	4.8	4.0	3.8	4.3
OCDD	46.9	14.1	8.0	12.3	14.2	20.7	15.0	12.9	18.0	6.9	41.0	18.4	15.2	12.5	8.0	26.9	15.5	17.9	18.0	18.0
378-TCDF	2.6	2.6	1.7	1.8	1.5	2.0	1.5	2.7	2.1	1.4	1.6	2.4	1.6	2.5	1.6	10.5	2.2	2.2	2.9	2.5
378-PnCDF	1.3	2.2	1.3	4.8	10.3	1.6	0.5	1.5	2.9	2.5	1.6	2.2	3.3	1.3	1.9	6.6	4.2	1.7	3.0	2.9
478-PnCDF	7.7	8.8	6.4	18.1	5.3	9.8	5.9	9.4	8.9	3.9	2.7	10.0	5.9	6.9	6.3	15.7	7.8	6.5	7.3	8.1
478-HxCDF	6.3	5.7	3.4	3.2	1.0	5.3	2.9	2.8	3.8	2.7	2.2	5.2	4.6	3.6	5.5	2.4	3.3	3.9	3.7	3.8
678-HxCDF	3.5	2.6	1.6	1.7	1.7	0.4	1.8	2.0	1.9	1.6	1.5	3.3	2.6	2.2	2.1	1.1	1.7	2.0	2.0	2.0
789-HxCDF	0.6	0.5	0.2	0.3	0.4	0.2	0.3	0.1	0.3	0.3	0.7	0.4	0.4	0.5	0.9	5.3	0.1	0.3	1.0	0.7
678-HxCDF	1.7	1.2	1.0	1.1	1.1	1.4	1.1	1.0	1.2	1.0	1.8	1.3	1.5	1.3	1.0	1.2	1.0	1.2	1.3	1.2
4678-HpCDF	6.0	2.1	1.5	1.4	2.9	1.9	2.4	1.6	2.5	1.8	0.1	2.5	3.7	2.0	1.4	5.2	1.9	1.8	2.3	2.4
4789-HpCDF	1.0	0.3	0.4	0.3	0.4	0.3	0.3	0.2	0.4	0.3	1.3	0.5	0.5	0.3	0.7	1.1	0.4	0.7	0.6	0.5
OCDF	3.5	0.6	0.4	0.7	9.7	0.5	0.6	0.7	2.1	0.7	89.8	0.6	1.3	0.8	1.0	2.1	0.3	0.6	10.8	5.8
ΣQ, pg/g lip.	25.9	27.1	10.1	19.9	9.8	14.3	8.7	11.6	15.9	5.7	9.0	21.9	7.8	10.6	9.5	26.7	12.9	11.2	12.8	14.4
Number of donors	17	5	1	1	1	10	5	3	43	2	1	9	1	3	3	2	2	2	23	66
Mean age	23.5	23.2	20	24	23	23.4	20.6	20	22.2	19	25	30.4	25	26	22.8	22	22	24	25.4	23.8

Table 3

PCDD/F contents in whole blood samples from cities and rural areas of Bashkortostan

PCDD/Fs	Salavat	Sterlitamak	Blagoveshchensk	Baymak	Beloretsk	Ishimbay	Kumertau	Uchaly	Yanaul	Beloretsky	Davlekanovsky	Iglinsky	Mechetlinsky	Sterlitamasky	Alshevsky	Uchalinsky
378-TCDD	6.1	10.2	19.0	4.8	4.1	3.2	4.7	4.9	11.5	3.7	3.0	2.6	4.8	3.0	9.6	4.0
378-PnCDD	1.8	9.8	19.0	3.9	2.0	6.3	2.0	7.8	15.1	1.9	7.9	6.8	18.3	6.3	10.2	3.5
1478-HxCDD	5.2	5.7	10.0	3.7	1.2	1.7	2.9	2.9	4.4	4.1	2.6	7.6	4.1	3.3	3.2	2.3
1678-HxCDD	8.2	9.1	5.5	2.2	4.3	2.9	6.0	6.3	8.3	6.4	5.1	15.3	8.4	1.5	6.7	12.6
1789-HxCDD	3.9	5.5	6.7	1.5	2.1	1.4	2.9	1.9	3.5	2.0	2.2	10.7	3.7	4.5	2.6	7.1
4678-HpCDD	25.1	26.9	24.0	30.3	9.1	20.9	17.8	16.6	17.7	14.4	12.0	28.4	18.3	21.2	9.3	28.6
OCDD	93.2	175	189	188	50.8	105	96.4	76.5	101	89.3	72.9	613	312	89.0	77.1	166
378-TCDF	10.4	25.8	19.2	10.0	8.8	7.5	7.3	10.6	22.2	18.1	8.2	23.2	5.4	6.5	4.6	5.7
378-PnCDF	6.4	7.4	3.4	5.0	4.6	2.2	4.1	5.9	18.3	7.8	2.8	13.8	10.9	7.4	9.5	3.9
478-PnCDF	21.6	34.3	24.2	26.4	11.6	21.3	14.2	17.2	24.7	17.7	13.1	29.9	2.2	5.0	13.5	4.0
1478-HxCDF	10.0	27.3	21.3	19.6	8.1	3.4	16.9	15.1	10.9	12.3	9.0	15.0	16.7	5.0	17.5	20.6
1678-HxCDF	7.0	9.7	5.4	7.9	5.4	3.3	11.5	8.8	10.0	7.6	5.7	12.3	10.1	5.0	6.3	13.0
1789-HxCDF	3.6	8.1	9.5	1.5	2.6	2.9	5.8	4.6	11.5	5.2	2.7	8.8	4.3	5.0	7.3	6.0
1678-HxCDF	6.7	9.2	8.6	3.4	4.2	1.4	9.3	7.1	11.0	7.4	5.1	12.5	4.0	5.0	4.9	10.6
4678-HpCDF	25.2	28.7	19.5	19.6	8.8	17.8	20.1	16.5	16.7	16.3	13.7	96.7	44.7	20.3	7.0	35.3
4789-HpCDF	4.4	4.0	7.2	2.9	1.9	3.7	3.3	3.6	2.9	3.0	2.9	10.5	7.6	5.7	3.9	3.4
OCDF	12.3	13.4	25.4	14.2	6.1	20.4	17.6	13.3	14.7	14.6	8.7	10.5	3.0	17.7	6.9	25.1
ΣQ, pg/g lip.	24.6	41.0	50.1	25.9	15.0	20.0	19.8	23.8	40.5	20.6	18.0	35.2	22.3	13.4	27.5	16.6
Number of donors	40	25	15	15	43	16	18	22	20	24	9	3	11	13	3	7
Mean age	42	39.5	24	27.5	23.5	36	36	37.5	32.5	35.7	31	25	25	41	42	43

Table 3

PCDD/F contents in whole blood samples from cities and rural areas of Bashkortostan

PCDD/Fs	Salavat	Sterlitamak	Blagoveshchensk	Baymak	Beloretsk	Ishimbay	Kumertau	Uchaly	Yanaul	Beloretsky	Davlekanovsky	Iglinsky	Mechetlinsky	Sterlitamasky	Alsheyevsky	Uchalinsky
2378-TCDD	6.1	10.2	19.0	4.8	4.1	3.2	4.7	4.9	11.5	3.7	3.0	2.6	4.8	3.0	9.6	4.0
12378-PnCDD	1.8	9.8	19.0	3.9	2.0	6.3	2.0	7.8	15.1	1.9	7.9	6.8	18.3	6.3	10.2	3.5
123478-HxCDD	5.2	5.7	10.0	3.7	1.2	1.7	2.9	2.9	4.4	4.1	2.6	7.6	4.1	3.3	3.2	2.3
123678-HxCDD	8.2	9.1	5.5	2.2	4.3	2.9	6.0	6.3	8.3	6.4	5.1	15.3	8.4	1.5	6.7	12.6
123789-HxCDD	3.9	5.5	6.7	1.5	2.1	1.4	2.9	1.9	3.5	2.0	2.2	10.7	3.7	4.5	2.6	7.1
1234678-HpCDD	25.1	26.9	24.0	30.3	9.1	20.9	17.8	16.6	17.7	14.4	12.0	28.4	18.3	21.2	9.3	28.6
OCDD	93.2	175	189	188	50.8	105	96.4	76.5	101	89.3	72.9	613	312	89.0	77.1	166
2378-TCDF	10.4	25.8	19.2	10.0	8.8	7.5	7.3	10.6	22.2	18.1	8.2	23.2	5.4	6.5	4.6	5.7
12378-PnCDF	6.4	7.4	3.4	5.0	4.6	2.2	4.1	5.9	18.3	7.8	2.8	13.8	10.9	7.4	9.5	3.9
23478-PnCDF	21.6	34.3	24.2	26.4	11.6	21.3	14.2	17.2	24.7	17.7	13.1	29.9	2.2	5.0	13.5	4.0
123478-HxCDF	10.0	27.3	21.3	19.6	8.1	3.4	16.9	15.1	10.9	12.3	9.0	15.0	16.7	5.0	17.5	20.6
123678-HxCDF	7.0	9.7	5.4	7.9	5.4	3.3	11.5	8.8	10.0	7.6	5.7	12.3	10.1	5.0	6.3	13.0
123789-HxCDF	3.6	8.1	9.5	1.5	2.6	2.9	5.8	4.6	11.5	5.2	2.7	8.8	4.3	5.0	7.3	6.0
234678-HxCDF	6.7	9.2	8.6	3.4	4.2	1.4	9.3	7.1	11.0	7.4	5.1	12.5	4.0	5.0	4.9	10.6
1234678-HpCDF	25.2	28.7	19.5	19.6	8.8	17.8	20.1	16.5	16.7	16.3	13.7	96.7	44.7	20.3	7.0	35.3
1234789-HpCDF	4.4	4.0	7.2	2.9	1.9	3.7	3.3	3.6	2.9	3.0	2.9	10.5	7.6	5.7	3.9	3.4
OCDF	12.3	13.4	25.4	14.2	6.1	20.4	17.6	13.3	14.7	14.6	8.7	10.5	3.0	17.7	6.9	25.1
TEQ, pg/g lip.	24.6	41.0	50.1	25.9	15.0	20.0	19.8	23.8	40.5	20.6	18.0	35.2	22.3	13.4	27.5	16.6
Number of donors	40	25	15	15	43	16	18	22	20.	24	9	3	11	13	3	7.0
Mean age	42	39.5	24	27.5	23.5	36	36	37.5	32.5	35.7	31	25	25	41	42	43

Table 1.

PCDD/F contents in breast milk of citizens, Bashkortostan

PCDD/Fs	Cities									Rural areas										
	Ufa	Blagoveshensk	Davlecanovo	Ishimbay	Kumertau	Neftecamsk	Salavat	Yanaul	Mean of cities	Baimaksky	Beloretsky	Iglinsky	Mechetlinsky	Mishkinsky	Salavatsky	Sterlitamaksky	Checmagushevsky	Ishimbaysky	Mean by areas	Mean (region)
2378-TCDD	13.5	13.6	3.5	9.4	3.8	5.3	2.9	3.6	7.0	1.6	2.4	9.3	2.0	3.9	3.1	10.6	4.8	4.0	4.6	5.7
12378-PnCDD	11.1	14.1	4.1	0.2	3.8	5.0	2.8	3.6	5.6	1.9	1.6	11.0	2.9	3.4	3.3	10.9	5.2	5.2	5.0	5.3
123478-HxCDD	2.8	2.2	1.8	1.2	1.0	1.6	0.7	1.1	1.5	0.4	0.5	1.9	0.7	1.2	0.8	1.0	1.3	0.9	1.0	1.3
123678-HxCDD	6.7	3.6	1.9	1.6	2.4	3.2	3.0	2.7	3.1	1.1	0.8	4.1	1.0	2.1	2.3	4.3	2.8	2.6	2.4	2.8
123789-HxCDD	2.1	0.6	0.4	0.3	0.8	0.7	2.1	0.9	1.0	0.3	0.6	0.9	0.4	0.7	1.7	3.7	0.4	0.5	0.9	0.9
1234678-HpCDD	10.7	3.6	2.6	3.1	3.1	5.4	6.7	3.5	4.8	2.1	2.7	4.1	3.2	3.2	1.9	8.0	4.8	4.0	3.8	4.3
OCDD	46.9	14.1	8.0	12.3	14.2	20.7	15.0	12.9	18.0	6.9	41.0	18.4	15.2	12.5	8.0	26.9	15.5	17.9	18.0	18.0
2378-TCDF	2.6	2.6	1.7	1.8	1.5	2.0	1.5	2.7	2.1	1.4	1.6	2.4	1.6	2.5	1.6	10.5	2.2	2.2	2.9	2.5
12378-PnCDF	1.3	2.2	1.3	4.8	10.3	1.6	0.5	1.5	2.9	2.5	1.6	2.2	3.3	1.3	1.9	6.6	4.2	1.7	3.0	2.9
23478-PnCDF	7.7	8.8	6.4	18.1	5.3	9.8	5.9	9.4	8.9	3.9	2.7	10.0	5.9	6.9	6.3	15.7	7.8	6.5	7.3	8.1
123478-HxCDF	6.3	5.7	3.4	3.2	1.0	5.3	2.9	2.8	3.8	2.7	2.2	5.2	4.6	3.6	5.5	2.4	3.3	3.9	3.7	3.8
123678-HxCDF	3.5	2.6	1.6	1.7	1.7	0.4	1.8	2.0	1.9	1.6	1.5	3.3	2.6	2.2	2.1	1.1	1.7	2.0	2.0	2.0
123789-HxCDF	0.6	0.5	0.2	0.3	0.4	0.2	0.3	0.1	0.3	0.3	0.7	0.4	0.4	0.5	0.9	5.3	0.1	0.3	1.0	0.7
234678-HxCDF	1.7	1.2	1.0	1.1	1.1	1.4	1.1	1.0	1.2	1.0	1.8	1.3	1.5	1.3	1.0	1.2	1.0	1.2	1.3	1.2
1234678-HpCDF	6.0	2.1	1.5	1.4	2.9	1.9	2.4	1.6	2.5	1.8	0.1	2.5	3.7	2.0	1.4	5.2	1.9	1.8	2.3	2.4
1234789-HpCDF	1.0	0.3	0.4	0.3	0.4	0.3	0.3	0.2	0.4	0.3	1.3	0.5	0.5	0.3	0.7	1.1	0.4	0.7	0.6	0.5
OCDF	3.5	0.6	0.4	0.7	9.7	0.5	0.6	0.7	2.1	0.7	89.8	0.6	1.3	0.8	1.0	2.1	0.3	0.6	10.8	5.8
TEQ, pg/g lip.	25.9	27.1	10.1	19.9	9.8	14.3	8.7	11.6	15.9	5.7	9.0	21.9	7.8	10.6	9.5	26.7	12.9	11.2	12.8	14.4
Number of donors	17	5	1	1	1	10	5	3	43	2	1	9	1	3	3	2	2	2	23	66
Mean age	23.5	23.2	20	24	23	23.4	20.6	20	22.2	19	25	30.4	25	26	22.8	22	22	24	25.4	23.8