DIOXIN-LIKE COMPOUNDS IN HUMAN MILK AND PLACENTA FROM CENTRAL VIETNAM

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Abstract

Contemporary levels of PCDD/Fs in placental tissues and in breast milk of women from central provinces of Vietnam were investigated. Quang Tri province was exposed by Agent Orange during the war of 1961–1972, neighbor Quang Binh province located to the north – was not. Quite high levels of PCDD/Fs in placental tissues and in breast milk were shown. 2,3,7,8-TCDD was detected in the placenta of only one woman from Quang Binh province. The levels of PCDD/Fs in the breast milk of parturient women from Quang Binh province were found to be significantly lower than in the women from Quang Tri. Despite of growing anthropogenic burden these differences could be caused by Agent Orange treatment of Quang Tri province. This fact indicates that, even today – after 40 years (in the third generation of people), trace amounts of dioxins from Agent Orange are retained in the bodies of humans permanently living in the area subjected to mass-scale treatment with defoliants.

Introduction

The study was performed with the placenta and breast milk of aboriginal women of two neighboring provinces Quang Binh and Quang Tri located in central Vietnam. Quang Tri is located along the 17th parallel, which was used as the demarcation line during the war of 1961–1972. Battles that took place in this area were accompanied by large-scale use of defoliants. One of these defoliants Agent Orange was sprayed in amounts of over 4000 l/km^2. Quang Binh province adjoins Quang Tri province in the north; no warfares were performed on its territory. The goal of this study was to assess the current level of PCDD/Fs in placenta tissues and breast milk of women living in Vietnam regions that were treated with defoliants during the war of 1961–1972 and in the adjacent uncontaminated regions.

Material and Methods

9 samples of placenta and 12 samples of breast milk were available for analysis in total. All samples were collected by employees of Russian-Vietnamese Tropical Center and analyzed in our laboratory by HRMS with the conventional procedure[1]. Pilot samples were collected in 2004, general pool of samples were obtained in 2007. In all calculations, values below the detection limit were taken to be equal to zero.

Results and Discussion

Placenta. The level of PCDD/Fs in the placenta of women living in Quang Binh and Quang Tri provinces varied in the range 14.6–48.5 pg WHO-TEQ$_{98}$/g lipids and 14.8-48.3 pg WHO-TEQ$_{98}$/g lipids, respectively. The average levels of PCDD/F congeners are shown in Table 1.

If consider samples of 2007 it is possible to conclude that the levels of PCDD/Fs were lower in placenta tissues of primiparous women. The content of PCDD/Fs tended to increase with age of parturient women (Fig. 1). The levels of PCDD/Fs in the placenta of women from Quang Binh and Quang Tri provinces proved to be comparable with the levels of dioxins and furans in the placenta of women living in Japan, a country with a high level of urbanization[2]; however, they were significantly higher than in women living in Taiwan and New York[3,4] (Fig. 2). Although the congener profiles in placenta tissues of women living in both provinces were similar (Tab. 1), the concentration of 2,3,7,8-TCDD in the samples from Quang Binh was approximately one order of magnitude lower than in the specimens from Quang Tri. It should be noted that 2,3,7,8-TCDD was detected in the placenta of only one woman from Quang Binh province.

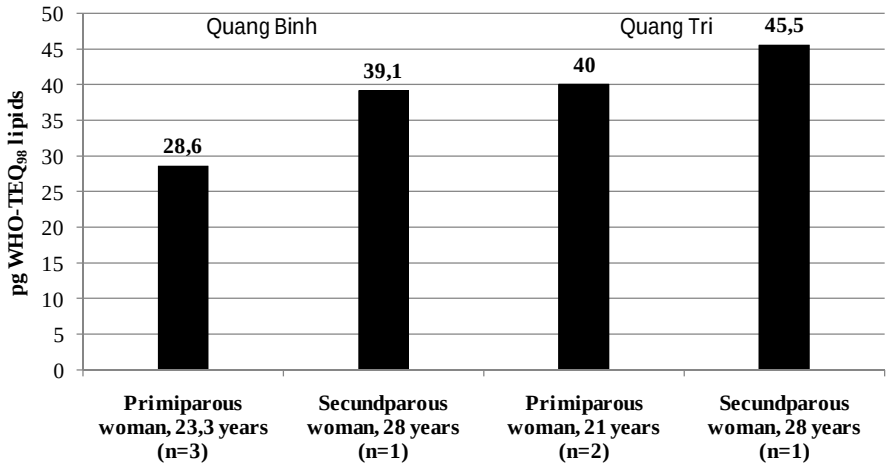

Fig. 1 PCDD/Fs levels in the placenta of primiparous and secundiparous women living in Quang Binh and Quang Tri provinces (in 2007).

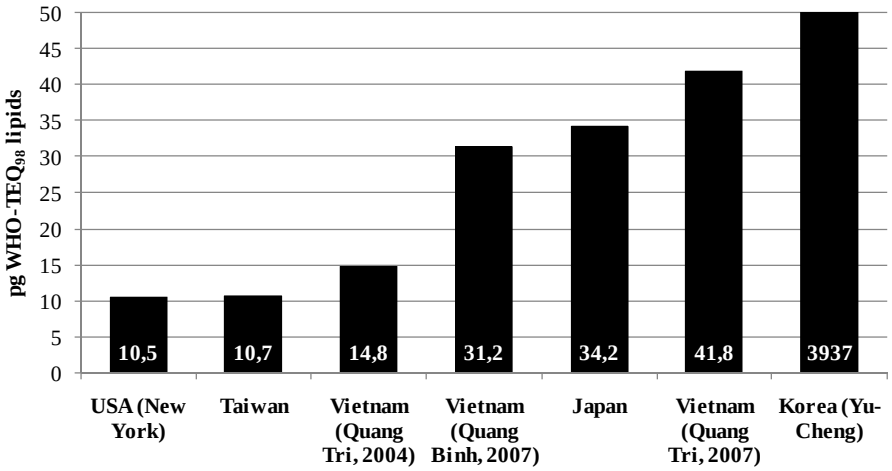

Fig. 2 Comparison of PCDD/PCDF levels in placenta tissues of women from Vietnam and other countries (for Yu-Cheng averaged data in I-TEQ[5]).

Table 1. PCDD/Fs and c-PCBs concentration in breast milk and placenta samples of women living in Quang Tri and Quang Binh provinces of central Vietnam, pg/g lipid.

Province	*Quang Tri*		*Quang Binh*		*Quang Tri*			*Quang Binh*	
	Breast milk				*Placenta*				
Sampling year	*2004/7*	*2004/7*[1]	*2007*	*2007*	*2007*	*2007*	*2004*	*2007*	*2007*
Childbirth	*1*	*2*	*1*	*2*	*1*	*2*	*unspecified*	*1*	*2*
Number of samples	*2+2*	*1+1*	*3*	*3*	*2*	*1*	*2*	*3*	*1*
2,3,7,8-TCDD	2,2	1,7	0,39	0,06	3,0	17,2	2,7	0,19	<0,8
1,2,3,7,8-PeCDD	3,4	2,3	1,7	1,5	12,7	6,1	5,8	7,5	15,0
1,2,3,4,7,8-HxCDD	2,7	2,0	1,9	1,5	10,9	11,8	2,9	6,2	13,6
1,2,3,6,7,8-HxCDD	8,7	5,6	5,5	4,1	6,6	8,0	3,0	7,3	8,1
1,2,3,7,8,9-HxCDD	2,4	1,6	2,4	1,7	1,2	1,6	1,5	1,6	<2,5
1,2,3,4,6,7,8-HpCDD	12,1	12,3	5,1	6,7	19,1	31,0	19,7	17,0	32,2
OCDD	75,9	135	27,0	37,3	122	705	153	110	340
2,3,7,8-TCDF	0,92	0,21	0,42	0,28	2,6	0,66	0,54	0,68	2,4
1,2,3,7,8-PeCDF	1,2	0,49	0,58	0,30	1,7	0,66	1,04	0,97	2,5
2,3,4,7,8-PeCDF	7,7	5,0	6,2	4,2	28,4	27,8	6,4	25,2	20,7
1,2,3,4,7,8-HxCDF	11,3	9,8	15,6	11,8	61,5	37,5	14,4	49,5	81,0
1,2,3,6,7,8-HxCDF	7,5	6,1	8,3	5,3	12,4	13,8	4,3	14,2	25,5
1,2,3,7,8,9-HxCDF	0,8	0,25	0,69	0,68	<1	0,95	<0,5	<1	<1,9
2,3,4,6,7,8-HxCDF	1,5	0,87	1,1	1,1	0,8	2,4	0,7	1,0	<1,6
1,2,3,4,6,7,8-HpCDF	8,4	7,7	7,1	8,2	13,5	13,4	6,1	9,7	13,5
1,2,3,4,7,8,9-HpCDF	1,2	0,86	1,1	1,0	2,9	<2	1,1	<1	<4,6
OCDF	2,0	2,1	0,46	2,2	<10	<10	3,5	<5	<20,6
PCB-77	28,1	24,8	35,2	37,4					
PCB-81	6,9	3,8	0,6	2,8					
PCB-126	40,3	23,4	18,7	31,8					
PCB-169	36,6	21,0	10,0	25,1					
WHO-TEQ$_{DF98}$	**13,3**	**9,4**	**9,0**	**6,4**	**40,0**	**45,5**	**14,8**	**28,6**	**39,1**
WHO-TEQ$_{DF2005}$	***11,7***	***8,4***	***7,7***	***5,6***	***34,3***	***40,0***	***13,5***	***23,6***	***35,0***
WHO-TEQ$_{c\text{-}PCB98}$[2]	**4,4**	**2,6**	**2,0**	**3,4**					
WHO-TEQ$_{c\text{-}PCB2005}$	***5,1***	***3,0***	***2,2***	***3,9***					

Breast milk. The concentration of PCDD/Fs in the breast milk of women living in Quang Binh and Quang Tri provinces varied in the range 5.1–13.7 pg WHO-TEQ$_{98}$/g lipids and 7.5–15.9 pg WHO-TEQ$_{98}$/g lipids, respectively. The concentrations of PCDD/Fs and c-PCBs in the breast milk of women from Quang Binh and Quang Tri provinces are given in table 1. Table 2 contains the results for extended list of PCBs and for some pesticides in beast milk samples from 2004. The content of PCDD/Fs in the breast milk of primiparous and secundiparous women from central Vietnam in comparison with worldwide data are in Fig. 3.

As in case of placenta samples, in comparison with 2004 sharp growth of concentration of the compound specifying in anthropogenous pollution observed (fig. 4). Though because of small quantity of the analysed samples it is impossible to assert, that it is a consequence of the general growth of pollution level in the region, but the analysis of foodstuff executed the same years showed the similar tendency. We also do not exclude probability that the reason of so significant distinctions was that samples were obtained in different villages.

[1] Sample of 2004 consisted from two individual sample.

[2] PCB 77, 81, 126 and 169

The results of this study showed that the levels of PCDD/Fs in all types of biological materials obtained from women living in Quang Tri province are higher than those detected in women from Quang Binh province.
The levels of PCDD/Fs in the breast milk of parturient women from Quang Binh province were significantly lower than in the women from Quang Tri. The concentration of dioxins in milk of primiparous women was 20–30% higher than in the samples from secundiparous women (Fig. 3). This difference almost did not depend on the age of parturient woman. The profiles of PCDD/Fs congeners in the breast milk of parturient women from either province were similar. Such congener pattern is indicative of diverse anthropogenic burden on the population of the provinces specified. Absence of 2,3,7,8-TCDD in the placenta and breast milk of women from Quang Binh province and the presence of this compound in the placenta and breast milk of women from Quang Tri province can be explained by living in the areas that were untreated and treated by defoliants respectively.
However, today, 40 years after the use of Agent Orange, the total level of 2,3,7,8-TCDD in tissues of the population of Southern Vietnam has decreased[6]. In addition, small quantities of 2,3,7,8-TCDD were detected in the blood, breast milk, and tissues of humans living in Northern Vietnam who had never been to the southern part of the country[7,8] and a priori had not been exposed to Agent Orange[9]. For this reason, the presence in tissues and fluids of humans of small quantities of 2,3,7,8-TCDD cannot be regarded as the consequence of spraying Agent Orange. Nevertheless, there are some differences in the content of 2,3,7,8-TCDD in tissues of people living in the areas treated and not treated with Agent Orange, which retain even nowadays.

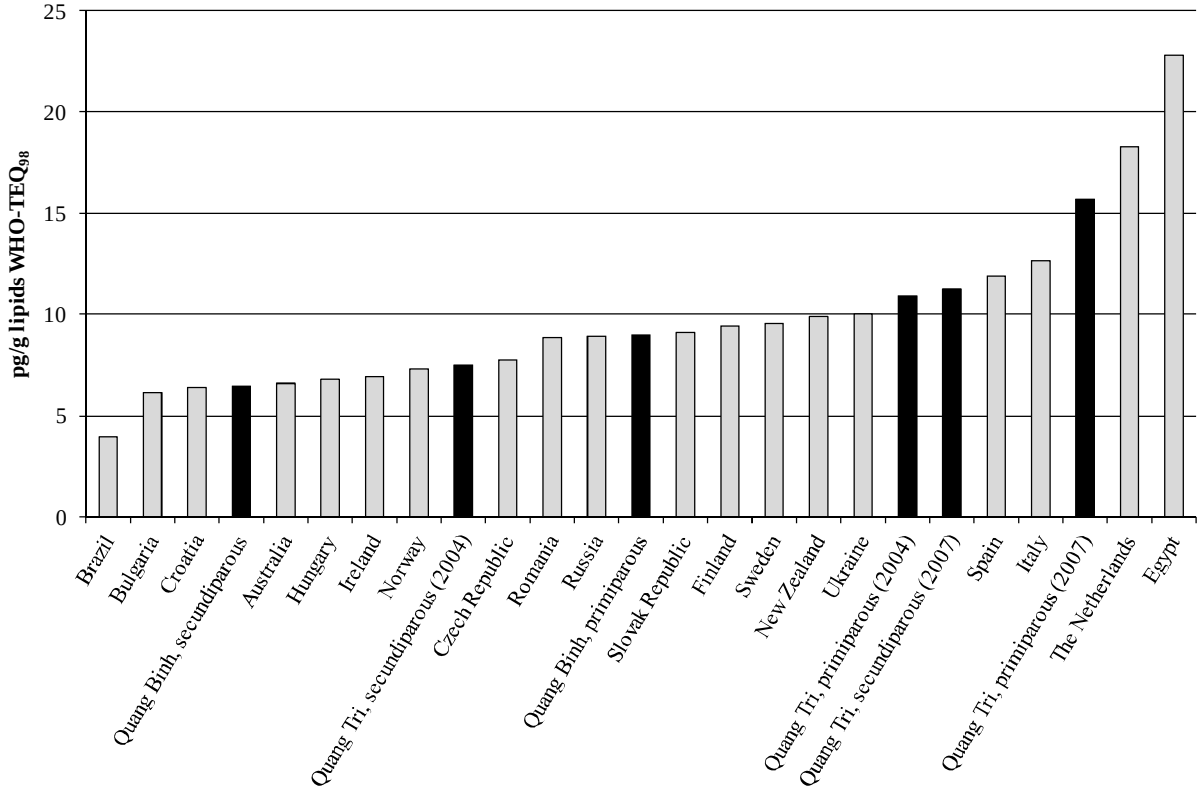

Fig.3 Levels of PCDDs and PCDFs in human milk, pg/g lipid WHO-TEQ$_{98}$ (grey filling – WHO 3rd round data[10], black filling – our data).

Table 2. PCBs and pesticides concentration in breast milk of women living in Quang Tri province (2004), pg/g lipid.

Village	**Gio Chan**	**Cam Lo**	
Childbirth	***1***	***1***	***2***
PCB-28	495	591	290
PCB-52	1450	4980	460
PCB-77	16,0	24,4	23,5
PCB-81	2,8	11,0	3,0
PCB-101	319	808	529
PCB-105	577	1365	800
PCB-114	106	141	109
PCB-118	1650	4250	1990
PCB-123	25	64	35
PCB-126	15,7	26,6	16,3
PCB-138	7590	24500	5760
PCB-153	1870	62100	10600
PCB-156	859	2854	745
PCB-157	207	401	199
PCB-167	228	735	179
PCB-169	16,0	26,9	10,0
PCB-180	31300	151000	23900
PCB-189	131	761	140
WHO-TEQ$_{98}$	**2,56**	**5,27**	**2,56**
HCB	1400	2700	1020
β-HCH	8470	11900	3710
γ-HCH	383	3320	149
o,p'-DDE	4410	8240	5440
p,p'-DDE	439400	1244000	587000
o,p'-DDT	1670	4060	2520
p,p'-DDT	28000	118000	43900
Heptachlorepoxide	353	ND	224
Oxychlordane	166	ND	< 100
trans-Nonachlor	623	1530	371
Mirex	307	3750	979

Thus, it can be postulated that the level of PCDD/Fs detected in placenta and breast milk specimens is quite high and corresponds to the level observed for industrially developed countries. The congener profile is primarily indicative of the current anthropogenic nature of the pollution. Quite high level of total pollution of the placenta and breast milk by dioxins, suggesting that the specified areas are environmentally unsafe, may be also due to secondary dioxin pollution resulting from the use of materials polluted with organochlorinated compounds. At the same time, in Quang Tri province, which was treated by defoliants, the content of PCDD/Fs in placenta and breast milk specimens (as well as the content of 2,3,7,8-TCDD characteristic for Agent Orange) is higher than in Quang Binh province, which was not treated by the warfare mixtures. This fact indicates that, even today (in the third generation), trace amounts of dioxins from Agent Orange are retained in the bodies of humans permanently living in the area subjected to mass-scale treatment with defoliants.

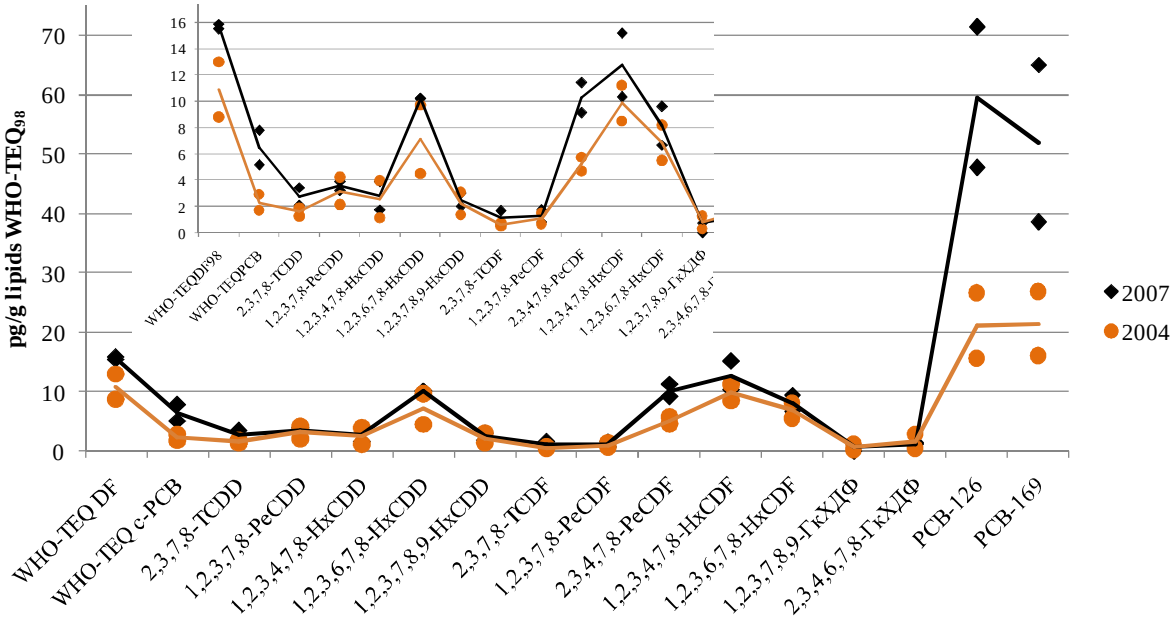

Fig. 4. Time variation of concentration for characteristic dioxin-like compounds in human milk of primiparous women from Quang Tri province.

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References
1. Cheleptchikov A.A., Kluyev N.A., Soyfer V.S., et al. *Organohalogen Comp*. 2002; 55: 81.
2. Nakano S., Noguchi T., Takekoshi H., et al. *Chemosphere* 2005; 61: 1244.
3. Chao H.-R., Wang S.-L., Lin L.-Y., et al. *Food Chem. Toxicol.* 2007; 45: 259.
4. Schecter A., Kassis I., Pépke O. *Chemosphere* 1998; 37: 1817.
5. Schecter A., Startin J., Wright C., Papke O., Ball M., Lis A. *Chemosphere* 1996; 32: 551.
6. Schecter A., Le Cao Dai, Pépke O., et al. *J. Occup. Environ. Med*. 2001; 43(5): 435.
7. Schecter A., Ryan J., Constable J. *Chemosphere* 1986; 15(9–12): 1613.
8. Schecter A., Vu D., Tong H.Y., et al. *Chemosphere* 1989; 19(1/6): 1001.
9. Schecter A., Tong H.Y., Monson S.J. *Chemosphere* 1990; 20(7–9): 943.
10. van Leeuwen FX R., Malisch R. *Organohalogen Comp*. 2002; 56: 311.