

VARIATION IN BLOOD DIOXIN LEVEL, CHARACTERISTICS OF ISOMER COMPOSITION, AND ISOMER CHANGES IN RESIDENTS NEAR AN INCINERATION FACILITY

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Introduction

Degree of dioxin exposure in humans has been evaluated by assaying the dioxin level in biological specimens. For biological specimens, blood, breast milk, fat, and organs such as the liver are used. In regards of biological specimens, only blood can be collected from a wide population of age groups regardless of gender. Many surveys have revealed contamination in humans using the blood dioxin concentration as an indicator. Previous studies reported a high exposure level of up to several hundred pg in blood. However, to determine human exposure from the blood level, it is necessary to investigate in detail daily changes and changes due to intermittent exposure to the emission source in the blood level. We have already reported the change of blood level during a three-month period in the general population in whom the blood concentration was at the control level, and confirmed that the change of level was maintained at a tolerance level¹⁾. In this study, we attempted to clarify variation in the blood dioxin level in residents near an incineration facility, the major source of dioxin, who were intermittently exposed, showing a higher level during a several-month period, and the characteristics of isomer composition and its changes. We researched the blood level in 14 residents near an incineration facility and evaluated the contamination level. In residents with higher dioxin levels, the blood level was monitored once a month and followed up for seven months.

Methods and Materials

About 100 ml of blood was collected from 14 residents near an incineration facility between October 2000 and February 2001. The 14 residents consisted of seven males and seven females, and ages ranged from 60 to 80 years old. Blood samples were kept standing overnight and centrifuged (3,000 rpm, 30 minutes), and the serum was collected. The serum, 25 g, was analyzed for 7 isomers of 2,3,7,8-PCDDs, 10 of 2,3,7,8-PCDF, 8 of mono- and 4 of non-ortho Co-PCBs. The analysis procedure was described previously¹⁾. Furthermore, blood samples were collected from three of the subjects with a higher dioxin level once a month for seven months from July 2001 to January 2002 and the dioxin level was measured.

Results and Discussion

To clarify variation of the blood dioxin concentration and characteristics and changes in the isomer composition in residents who were possibly intermittently exposed to dioxin, we researched the blood dioxin level in 14 residents near an incineration facility, which is the major source of dioxin. A blood

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dioxin level of 75 pg or higher was observed in five of the 14 residents (resident A-N). Fig. 1 shows the composition ratios of 29 isomers in the five residents (resident B, C, D, E and F). The major components of dioxin present in blood are four isomers: 1,2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; 3,3',4,4'-PeCB; and 2,3,3',4,4',5-HxCB; and the ratios of these isomers to the total TEQ were 14-18 %, 11-23 %, 19-48 %, and 4.6-12 %, respectively. For classification, 1, 2, 3, 7, 8-PeCDD, 2, 3, 4, 7, 8-PeCDF, 3, 3', 4, 4'-PeCB, and 2, 3, 3', 4, 4', 5-HxCB were included in PCDDs, PCDFs, nono-ortho PCBs, and mono-ortho PCBs, respectively. The four major isomers belonged to the four congeners of the classification of 29 dioxin isomers: one each in PCDDs, PCDFs, non-ortho PCBs, and mono-ortho PCBs. Of the remaining 25 isomers, 14 were minor components accounting for 1.0 % or less. This tendency was common in the five residents. We measured previously the blood levels of five donors of the general population during a three-month period as a control the dioxin level¹⁾. The isomer composition ratios showed that the same five isomers were major components in the five donors. Compared with the four major isomers in the residents with a high dioxin level and the five major isomers in the donors of the general population control group, the major isomers in the residents were 1, 2, 3, 7, 8-PeCDD, 2, 3, 4, 7, 8-PeCDF, 3, 3', 4, 4'-PeCB and 2, 3, 3', 4, 4', 5-HxCB, while the five major isomers in general population included these four isomers and 1, 2, 3, 6, 7, 8-HxCDD (Fig. 1).

Table 1 shows the total TEQ concentrations of blood dioxin measured once a month for seven months in three residents (resident B, D and E). In resident B, the highest and lowest blood dioxin levels during the seven-month period were 106 pg and 69 pg, respectively, and the lowest level corresponded to 65 % of the highest level, showing that the dioxin concentration was maintained at a relatively high level for seven months. The highest level was 113 pg in resident D, which was higher than that in resident B, but the lowest level was 43 pg, which corresponded to 38% of the highest level. In resident E, the lowest level was less than 50 % of the highest level, as in resident D, showing that the blood dioxin level varied two-fold or more over several months.

Fig. 2 shows the isomer composition and its changes during the seven-month period in the three residents (resident B, D and E). In subject B, the four isomers described above were the major components in the first measurement. The 3,3',4,4',5-PeCB level was the highest, and the level decreased in the order of 1,2,3,7,8-PeCDD; 2,3,4,7,8-PeCDF; and 2,3,3',4,4',5-HxCB. These four major components accounted for 80 % or more of the total amount of the 29 isomers. Furthermore, the ratio was higher than 70% in seven measurements during the seven-month period, showing no marked change in the isomer composition ratios. Similar results were observed in subjects D and E. The four isomers were the major components and no significant change in the composition was observed. These findings showed that although the blood level varies two-fold or more over several months, the major components in the isomer composition do not change. From these results of the residents near the incineration facility and of general population, we speculated that the total TEQ concentration of 29 isomers could be calculated from the TEQ concentrations of the five characteristic isomers present in blood. The correlation of the TEQ concentrations of the five isomers with the total TEQ concentration of 29 isomers was investigated in 60 analytical values in 14 subjects living near an incineration facility: seven measurements during a seven-month period in three subjects with a high dioxin level and five measurements during a three-month period in the five control subjects. Very high positive correlation with $R^2=0.99$ was obtained (Fig. 3). Matsueda et al. reported that the TEQ concentration of blood 2,3,4,7,8-PeCDF was correlated with the sum of TEQ of 20 isomers with $R^2=0.838$ ²⁾. Kitamura et al proposed that since the TEQ levels of eight isomers were correlated, they can be converted into the total TEQ concentration of 20 isomers³⁾. We included eight mono-ortho Co-PCBs and one non-ortho Co-PCBs in this study and concluded that the TEQ value of the five isomers can be converted into the TEQ value of the 29 isomers. However, the blood sampling volume can be reduced by measuring only isomers that are characteristically present at a high level in blood and converting them into the total

TEQ value, which decreases the burden on subjects and allows multiple tests, leading to more precise evaluation of the exposure level.

References

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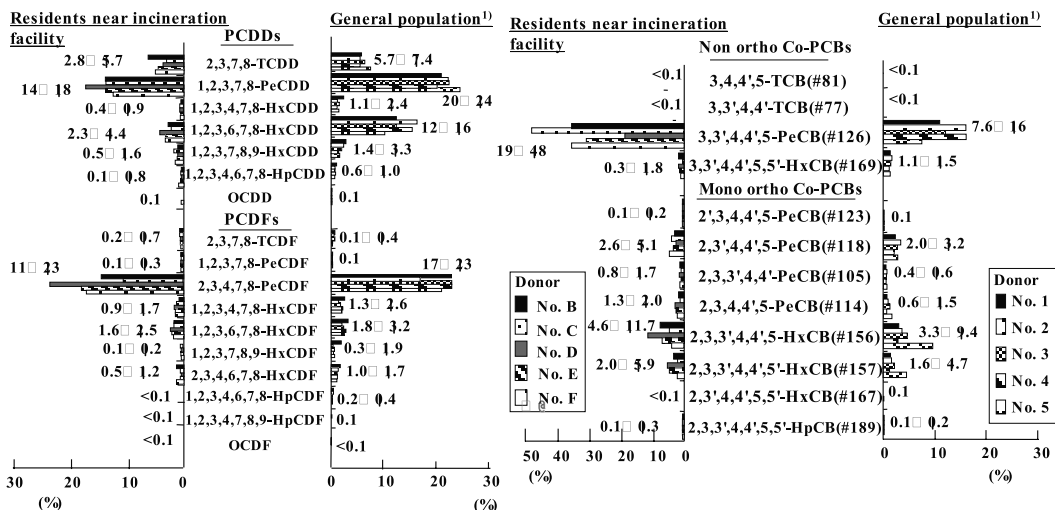


Fig. 1 The isomer composition in TEQ concentration of dioxins in serum of five residents near incineration facility and general population (PCDDs + PCDFs + Co-PCBs = 100 %)

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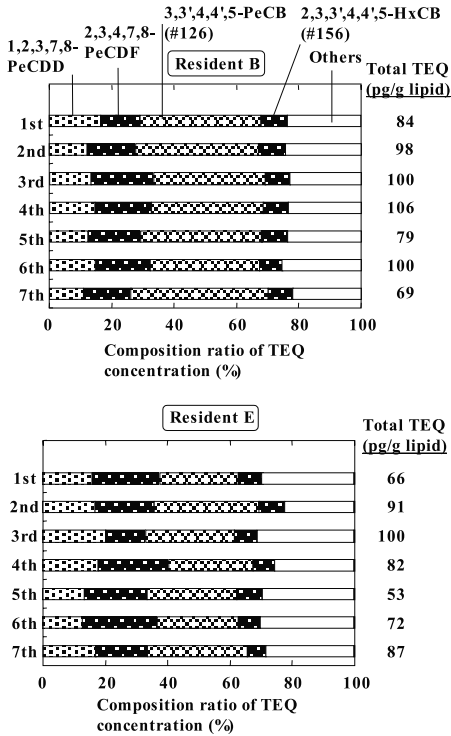


Fig. 2 Monthly variation in TEQ concentration, changes of isomer composition over 7 months

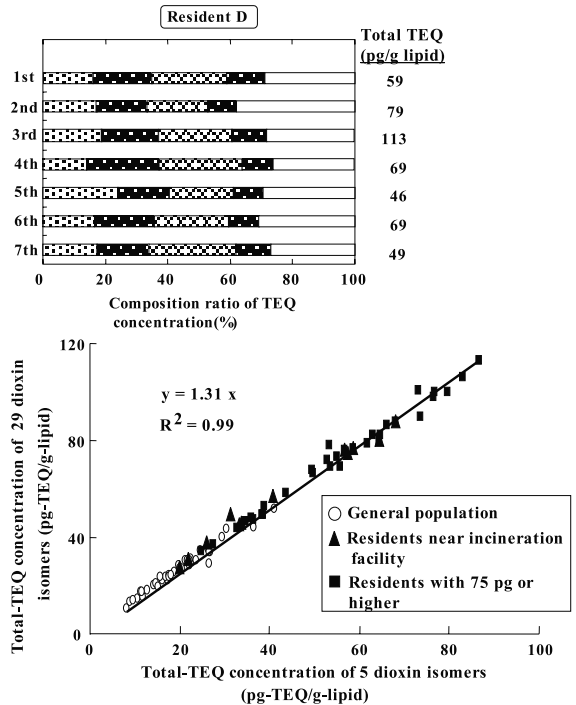


Fig. 3 Relationship between Total TEQ concentration of 29 dioxin isomers and that of major 5 dioxin isomers