ABUNDANCE RATIO OF DIOXINS IN HUMAN BLOOD FRACTION

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Introduction

In order to grasp the amount of dioxins accumulated in the human body, it is common to measure dioxins in the blood, and the necessity in understanding the accumulation of dioxins in human body will increase more and more in the future. However, no standardized measurement methods were present in the past – some cases used whole blood where others used serum, etc. Although it is believed that dioxin is mainly present in fat of the blood, not many are reported on the abundance ratio of blood fractions such as plasma and cells. In this study, we aimed to measure dioxins in Japanese blood to clarify their abundance ratios.

Materials and methods

Sample collection

About 21 mL of blood from 30 staff members of IDEA Consultant, Inc. (26 males, 4 females, average age 41.7 years old) was collected in a blood collection 7mL ×3 tube containing anticoagulant (EDTA-2Na). One of the three tubes was used as a sample of whole blood. After standing still for 15 minutes, the other two tubes were centrifuged (3000 rpm, 15 minutes), the supernatant was used as a plasma sample, and the precipitate was used as a blood cell sample.
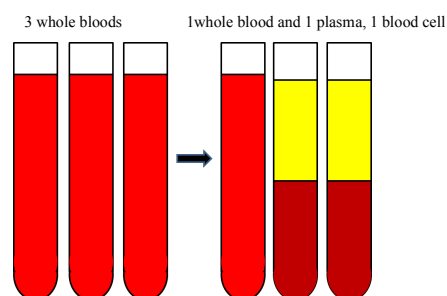
Sample analysis

Fats in the blood were extracted and was measured by mass injection method by using high resolution GCMS (HRGC / HRMS). HRGC used was 6890 series GC system by Agilent, and HRMS was AutoSpec - Ultima by Micromass. The measured dioxins are 7 PCDDs, 10 PCDFs, 4 non-*ortho* PCBs, and 8 mono-*ortho* PCBs. The measurement method was based on the method of survey conducted by the Ministry of the Environment of Japan.

Results and discussion

Dioxins contained in the extracted fat were analyzed. The dioxin concentrations are shown in Table 1. The average concentration of dioxins in 30 subjects was 10 pg-TEQ/g-fat for whole blood, 13pg-TEQ/g-fat for plasma, and 6.1pg-TEQ/g-fat for blood cells. Dioxins in blood cells concentration was the lowest.

The dioxin abundance per blood collection tube (7 mL) was calculated by multiplying the dioxins concentration by the fat mass,. The concentration of whole blood, plasma, and blood cell was 0.34pg-TEQ, 0.24pg-TEQ, and 0.089pg-TEQ, respectively, and the combined value of plasma and blood cell concentration was nearly equal to the whole blood concentration.

Plasma dioxin content in whole blood was 73% and blood cell dioxin was 27%, plasma dioxin content resulted higher than dioxin in blood cells.

Figure 1 summarizes the relationship between dioxins in whole blood and plasma of 30 subjects. Overall variation was small, and the correlation coefficient between dioxin in whole blood and plasma was high. Table 2 and Fig.3 summarizes the average concentration of dioxins and abundance ratio for each isomer.

In the monitoring surveys conducted in the past, many cases used whole blood and plasma when measuring the concentration of dioxins in the blood. For such reason, it was difficult to compare the data from the past. However, the results obtained from this study suggests that it is possible to compare the data from the past by introducing a coefficient factor, as a high correlation was found between the concentration of dioxins in whole blood and plasma was found,.
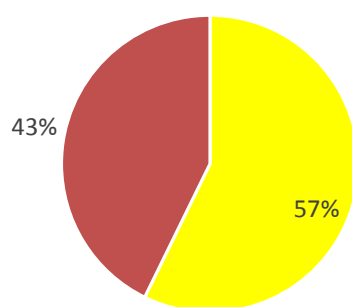
Table 1.   Dioxin concentration and abundance ratio by blood fraction.

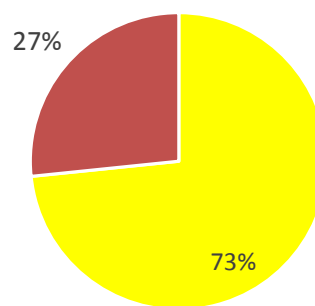| Fractionation	Concentration of dioxins (pg-TEQ/g-fat, mean ± SEM)	Dioxin abundance in 7mL of whole blood (pg-TEQ/ tube, mean±SEM)	Abundance ratio in whole blood
Whole blood	10 ± 5.7	0.34 ± 0.20	-
Plasma	13 ± 6.6	0.24 ± 0.15	73%
Blood cell	6.1 ± 3.9	0.089 ± 0.041	27%

Weight ratio of plasma and blood cells
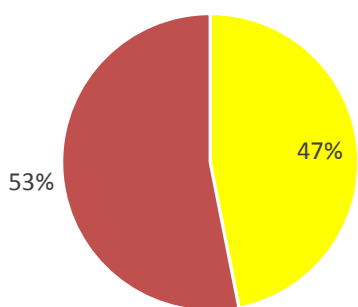
Fat weight ratio of plasma and blood cells

Abundance ratio of dioxin

Fig. 1. Weight ratio, fat weight ratio and dioxin abundance ratio of plasma and blood cell.
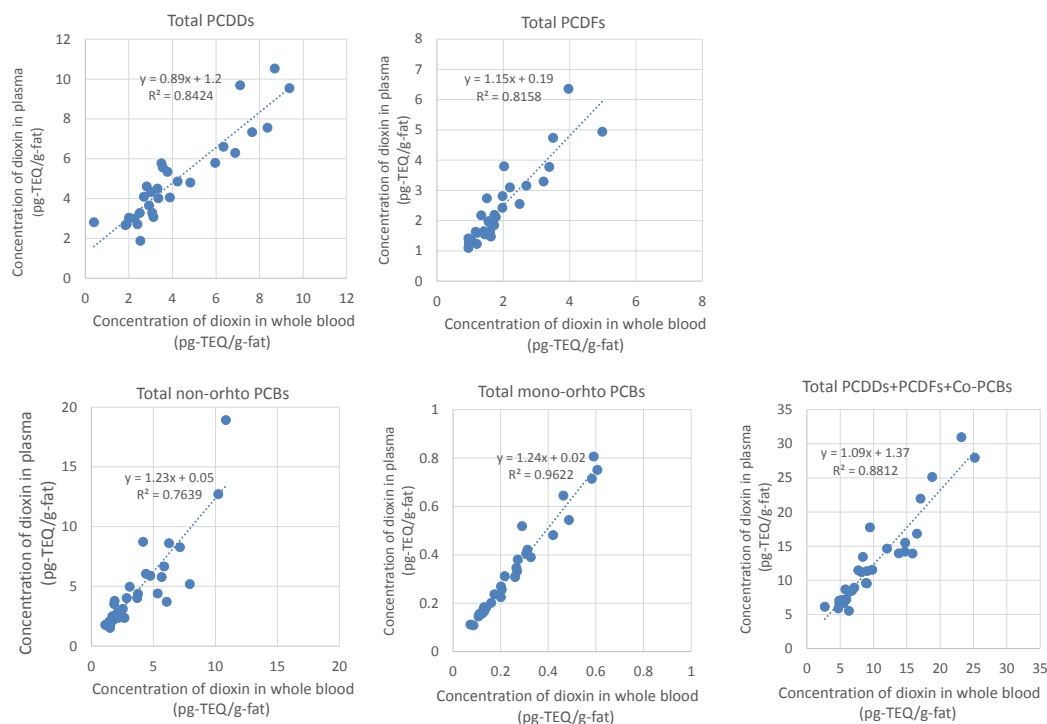

Fig. 2. Relationship between whole blood dioxin and plasma dioxin.

Table 2. Concentration of dioxins in each fraction.

Isomer		Average concentration of dioxins (pg-TEQ/g-fat)			The abundance ratio of plasma in whole blood
		Whole blood	Plasma	Blood cell	
PCDDs	2,3,7,8-TeCDD	0.56	0.64	0.56	59%
	1,2,3,7,8-PeCDD	2.5	2.9	2.0	65%
	1,2,3,4,7,8-HxCDD	0.098	0.11	0.046	75%
	1,2,3,6,7,8-HxCDD	0.81	0.99	0.43	74%
	1,2,3,7,8,9-HxCDD	0.13	0.17	0.13	62%
	1,2,3,4,6,7,8-HpCDD	0.075	0.096	0.063	66%
	OCDD	0.028	0.035	0.016	73%
PCDFs	2,3,7,8-TeCDF	0.063	0.054	0.13	34%
	1,2,3,7,8-PeCDF	0.0091	0.011	0.011	56%
	2,3,4,7,8-PeCDF	1.4	1.7	0.91	70%
	1,2,3,4,7,8-HxCDF	0.17	0.20	0.13	66%
	1,2,3,6,7,8-HxCDF	0.26	0.34	0.14	75%
	1,2,3,7,8,9-HxCDF	N.D.	N.D.	N.D.	0%
	2,3,4,6,7,8-HxCDF	0.070	0.093	0.047	71%
	1,2,3,4,6,7,8-HpCDF	0.019	0.027	0.013	73%
	1,2,3,4,7,8,9-HpCDF	0.00027	N.D.	0.00030	0%
	OCDF	N.D.	N.D.	N.D.	0%
non-*ortho* PCDs	3,3',4,4'-TeCB	0.00013	0.00014	0.00056	24%
	3,4,4',5-TeCB	0.000060	0.00013	0.000040	80%
	3,3',4,4',5-PeCB	3.1	3.8	1.1	82%
	3,3',4,4',5,5'-HxCB	0.77	1.1	0.34	79%
mono-*ortho* PCDs	2,3,3',4,4'-PeCB	0.026	0.031	0.013	75%
	2,3,4,4',5-PeCB	0.0085	0.011	0.0036	80%
	2,3',4,4',5-PeCB	0.12	0.15	0.058	77%
	2',3,4,4',5-PeCB	0.0020	0.0027	0.00091	79%
	2,3,3',4,4',5-HxCB	0.059	0.076	0.026	79%
	2,3,3',4,4',5'-HxCB	0.016	0.021	0.0068	79%
	2,3',4,4',5,5'-HxCB	0.021	0.029	0.0086	81%
	2,3,3',4,4',5,5'-HpCB	0.0077	0.010	0.0032	80%
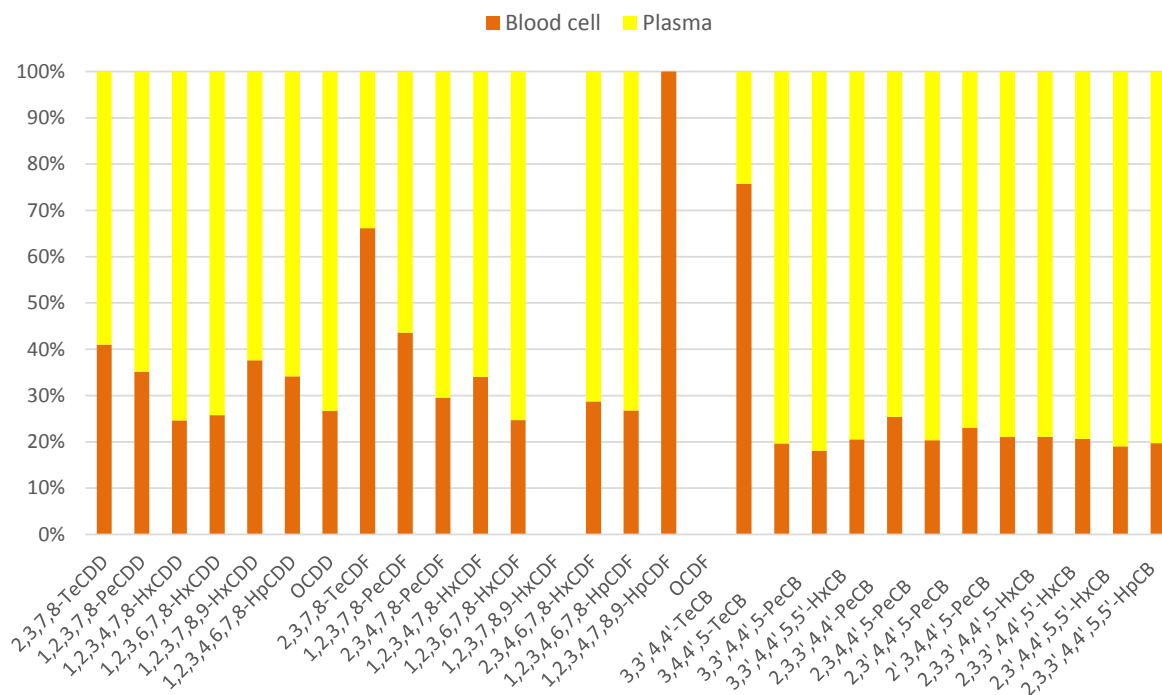
Fig. 3. Abundance ratios by isomers.

Reference

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