RISK ASSESSMENT OF PFOA, PFOS AND DETAMINATION OF PERFLUORINATED COMPOUNDS IN BLOOD

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Abstract

The investigation was carried out to estimate the risk assessment using environmental and uptake investigation of the contamination of PFOA and PFOS. We estimated an inhalation intake from the atmosphere and ingestion intake from the meal sample and drinking water of the investigation that we made the detection maximum concentration of on adult. We estimated MOE about PFOA. LOAEL used 50mg/kg/ day. As a result, we can judge it from this study if the concern of the health risk of PFOA in the meal, ambient air, drinking water intake that supposed is low. In the same way, we estimated MOE about PFOS with NOAEL used 0.025mg/kg/ day. MOE is over than 100, so we can judge it from this study that PFOS risk supposed is low.

And we measured PFCs in the blood samples taken from 2 co-researchers for this study. In the PFOA and PFOS concentration, a male is higher than a female.

Introduction

The both perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) have properties of hydrophilic as well hydrophobic and are widely used as surfactants. As a result, the environmental pollution of PFOA and PFOS has become a big matter on the environmental problem in Europe and USA. Also in Japan, a national-wide investigation for PFOA and PFOS have been carried out and widely distributed contamination has been clarified .So we have been studied this matter in environmental river water from 2006 [1,2] .

In this May 2009, Perfluooctanesulfonic acid and its salts, and PFOS-related substances were listed in the Stockholm Convention on Persistent Organic Pollutants (POPs). But these substances were widely used and there is no replacement. So these substances were grouped in Annex B, we can be admitted the usage some of products such as photoresists and so on.

So we are considered the Perfluooctanesulfonic acid and its salts, and PFOS-related substances have been detected in environment, human body.

In previous our report[1], we reported that high contaminations of PFOA and PFOS in Kinki Region were pointed out. So in this study, because of PFOA and PFOS weren't established the standard value for criterion, the risk assessment using environmental and uptake investigation of the contamination of PFOA and PFOS.

Additionally we measured the donated blood and serum sample from our co-researcher.

In this study, we report our risk of the PFOA and PFOS in Japan, and the concentration of PFOA, PFOS and these-related compounds in blood.

Materials and Methods

Risk assessment of PFOA and PFOS

We used quantity of revelation and a hazardous property coefficient of PFOA and PFOS and estimated MOE about PFOA, PFOS. The national investigation managed by Ministry of the Environment is the one which do not investigate the residual situation of the chemical substances to be able to put all over the general environment since 1974. The density of PFOA and PFOS intended for environment water gathered in Japan in 2005 from 2002, sediment, creature (shellfish, fish), meal samples, ambient air and measured it. In this study, we used the ambient air, a meal sample which human took in the body and estimated MOE. The PFOA, PFOS detection situation is shown in Table 1-1 and 1-2. Addition to this survey, in Hyogo pref. we measured PFOA and PFOS in drinking water, 2007. This result is shown in Table 1-1 and 1-2, too.

Drinking water sample pretreatment using solid phase extraction was performed based on the method by Sasaki et al [3]. Analytical condition of LC/MS is shown in Table2-1. The quantification limits are 1ng/L for PFOA and PFOS.

Estimated intake is calculated from detection maximum concentration of the ambient air, meal sample on adult and intake volume. The day average intake of the ambient air for adult is assumed 20m^3, the quantity of meal

took in 2,000g, the volume of the drinking water 2L.

Determination of Perfluorinated compounds (PFCs) in blood

We used the blood samples taken from 2 co-researchers for this study.
One is an umbilical cord blood sample after birth, and the another one is whole blood.
After the blood samples was drawn using heparin as anti - coagulant agent, a part of whole blood was centrifuged at g for 10min to prepare serum.
Blood sample pretreatment was performed based on the method by Hansen et al [3]. We added the surrogate spike of 2ng, 0.5M-TBA solution of 1ml, 0.25M-sodium carbonate buffer solution of 2ml, MTBE solution of 5ml to whole blood or serum 1g, and concussion stirred it for 20 minutes and separated and extracted the MTBE phase by centrifugal separation twice more.
We concentrated extract under a nitrogen current using TurboVap and added methanol 1mL . We filtered it by a 0.2um filter and analysed.
Analytical condition of LC/MS is shown in Table2-2.
The quantification limits are 0.1ng/mL for PFCs.

Table 1-1 Detection of PFOA in survey

Sample	Year	Frequency in detection	Range of detection	LOD
Meal (ng/g-wet)	2004	10 / 50	N.D～0.024	0.01
Ambient air (pg/m^3)	2004	60 / 60	0.22～5,300	0.14
Drinking water (ng／L)	2007	19 / 22	＜1～33	1

Table 1-2 Detection of PFOS in survey

Sample	Year	Frequency in detection	Range of detection	LOD
Meal (ng/g-wet)	2004	46 / 50	N.D～0.12	0.0033
Ambient air (pg/m^3)	2004	57 / 60	N.D～44	0.09
Drinking water (ng／L)	2007	14 / 22	1～17	1

Table 2-1. Analitical condition for PFOS and PFOA with LC/MS (Drinking water)

[HPLC]		[MS]		
Instrument	Agilent 1100	Instrument	Finnigan LCQ	
Column	Ascentis C18 (15cm×4.6mm , pore size 5μm)	Ionization	ESI	
		Polarity	Negative	
Mobile phase	A ; 10mM CH_3COONH_4/H_2O	Capillary temp.	275 ℃	
	B ; CH_3CN	Source voltage	5 kV	
(gradient condition)	B) 50% (0min) - 90% (9min) - - 50% (12min) - 50% (14min)	Capillary voltage	-20 V	
		Tube lens voltage	10 V	
Flow rate	0.5 mL / min	N_2 gas flow rate	70 arb	
Oven temp.	40 ℃	SIM ion	PFOS	499
Injection volume	10 μL		PFOA	413
			PFOA -$^{13}C_2$	415

Results and Discussion

Risk assessment of PFOA and PFOS with exposure estimation of intake

We estimated an inhalation intake from the atmosphere and ingestion intake from the meal sample and drinking water of the investigation that we made the detection maximum concentration of on adult. The day average intake of the atmosphere assumed that adult 20m^3, the quantity of meal took in 2,000g and 2L in adult.
As a result, we made a calculated guess the following data.

Meal : 0.024ng/g × 2000g=48ng/ person / day
Ambient air : 5.3ng/m^3 × 20m^3=106ng/ person / day
Drinking water : 33ng/L × 2L=66ng/ person / day on PFOA
And the other hand, it is estimated that was taken in as for PFOS
Meal : 0.12ng/g × 2000g =240ng/ person / day
Ambient air : 44pg/m^3 × 20m^3 = 0.88ng/ person / day on PFOS.
Drinking water : 17ng/L × 2L=34ng/ person / day

[Risk assessment of PFOA]

With quantity of revelation provided this time, we estimated MOE about PFOA. LOAEL used 50mg/kg/ day. This value is the result that influence was accepted by the reproduction toxicity when we administer PFOA orally to a New Zealand heron. The weight used adult 70kg.

As a result, MOE in the meal, ambient air and drinking water of the each independent intake is followed.

Meal : 50mg/kg/ day /(48ng/ person / day /70kg) =72,000,000 > 1,000
Ambient air : 50mg/kg/ day /(106ng/ person / day /70kg) =33,000,000 > 1,000
Drinking water : 50mg/kg/ day /(66ng/ person / day /70kg) =53,000,000 >1,000

Because we exceeded 1,000 that are the product of the uncertainty factor that we estimated with hazardous property of LOAEL much, we can judge it from this study if the concern of the health risk of PFOA in the meal, ambient air, drinking water intake that supposed is low.

[Risk assessment of PFOS]

With quantity of revelation provided this time, we estimated MOE about PFOS. NOAEL used 0.025mg/kg/ day. As a result of this value added K-salt of PFOS in the bait of the rat, and having administered it for two years, dominant increase was provided from an approved result in hepatocyte enlargement of the small leaf centricity of the liver, basophilia granule denaturation, pigmentation and an incidence of the vacuolation. The weight used adult 70kg.

As a result, the MOE in the meal, ambient air, and drinking water of the each independent intake is followed.

Table1 2-2 Analitical condition for PFCs

LC conditions						
Instrument	: ACQUITY UPLC (waters)					
Column	: UPLC BEH C18 2.1×50mm					
Retention gap Column	: UPLC BEH C18 2.1×100mm					
Mobile Phase	: A : 10mM Ammonium Acetate aq					
	B : Acetonitrile					
Gradient	: 0.0→8.0min B : 1→95%					
	8.0→8.1 B : 95→1%					
Flow rate	: 0.3 mL/min					
Column temp.	: 50℃					
Injection volume	: 5μL					
MS/MS conditions						
Instrument	: ACQUITY TQD (waters)					
Ionization Mode	: ESI(-)					
Source temp	: 120℃					
Desolvation temp	: 300℃					
Capillary voltage	: 2 kV					
Cone gas flow	: 20 L/Hr					
Desolvation gas flow	: 800 L/Hr					
Collision Gas Flow	: 0.1 mL/Min					
		Quantification ion [m/z]	Cone Voltage [V]	Collision Energy [eV]	Confirmation ion 1 [m/z]	Confirmation ion 2 [m/z]
PFBA	:	213.00 > 169.00	15	11		
PFPeA	:	263.00 > 219.00	18	9		
PFHxA	:	313.00 > 269.00	18	9	313.00 > 118.90	
PFHpA	:	363.00 > 318.90	18	11	363.00 > 169.00	
PFOA	:	413.00 > 368.90	18	11	413.00 > 169.00	
PFNA	:	463.00 > 418.90	18	13	463.00 > 169.00	
PFDA	:	513.00 > 468.90	21	13	513.00 > 219.00	
PFUnDA	:	563.00 > 518.80	18	15	563.00 > 269.00	
PFDoDA	:	613.00 > 568.90	24	15	613.00 > 168.90	
PFTrDA	:	663.00 > 618.80	24	17	663.00 > 169.00	
PFTeDA	:	713.00 > 668.70	24	15	713.00 > 169.00	
mass-labelled	:					
PFBA - $^{13}C_4$	:	217.00 > 172.00	15	13		
PFHxA - $^{13}C_2$	:	315.00 > 270.00	15	11		
PFOA - $^{13}C_4$	:	417.00 > 371.90	27	11		
PFNA - $^{13}C_5$	:	467.00 > 422.90	24	15		
PFDA - $^{13}C_2$	:	515.00 > 469.80	21	14	515.00 > 219.00	
PFUnDA - $^{13}C_2$	:	565.00 > 519.80	21	17	565.00 > 269.60	
PFDoDA - $^{13}C_2$	:	615.00 > 569.90	24	14	615.00 > 269.50	
PFBS	:	299.00 > 79.90	51	37	299.00 > 98.90	
PFHxS	:	399.00 > 79.90	57	46	399.00 > 98.80	399.00 > 130.00
PFOS	:	499.00 > 79.90	69	55	499.00 > 98.90	499.00 > 130.00
PFDS	:	599.00 > 79.90	80	67	599.00 > 98.90	599.00 > 79.90
mass-labelled						
PFHxS - $^{18}O_2$	:	403.00 > 83.90	55	47	403.00 > 103.00	
PFOS - $^{13}C_4$	:	503.00 > 79.90	65	56	503.00 > 99.00	

Meal : 0.025mg/kg/ day /(240ng/ person / day /70kg) =7,200 > 100
Ambient air : 0.025mg/kg/ day /(0.88ng/ person / day /70kg) =1,980,000 > 100
Drinking water : 0.025mg/kg/ day /(34ng/ person / day /70kg) =51,400 > 100

Because we exceeded 100 that are the product of the uncertainty factor that we estimated with hazardous property of NOAEL, we can judge it from this study if the concern of the health risk of PFOS in the meal, ambient air, drinking water intake that supposed is low.

Perfluorinated compounds (PFCs) in blood

The PFCs concentrations in whole blood and serum are shown in Fig.1. And Chromtogram of PFCAs in serum as an example is shown in Fig.2.

The measured PFCs are from C6(PFHxA) to C14(PFTeDA) for PFCAs and C6(PFHxS), C8(PFOS), C10(PFDS) for PFASs. In female umbilical cord blood sample and male serum sample are detected all target compounds except PFDS. The other side, in male whole blood sample is detected all target compounds. In all samples PFOA is highest for PFCAs and PFOS is highest for PFASs. In Fig.1, the PFOA and PFOS concentration, and a male is higher than a female, and this result is jibed with a report of Harada[5]. And according to the Harada's[5] and Fei 's[6] report, PFOS is higher than PFOA in serum sample. But in our data isn't jibed with this report. That means male blood and serum sample's PFOS are higher than PFOA, but female

umbilical cord blood sample's PFOS is lower than PFOA. In this study, we just measure only one sample of each. So it is difficult to explain this reason due to difference between sample or individual or sex or age and so on. Through some references, we should discuss about this matter.

And on evaluation of PFCs, it is used serum value by much epidemiology investigation, and there are not many reports in the whole blood. However, because PFCs is connected to albumin in blood if depend on a report of Nakai[7]; hematocrit (Ht) conversion value can use even serum is almost same as whole blood value. And in this male whole blood value calculated by Ht, it is almost same with serum.

In this study, it was confirmed that serum values accorded with Ht conversion value of the whole blood like a report of Nakai[7] well.

Fig.1 PFCs concentrations in whole blood and serum

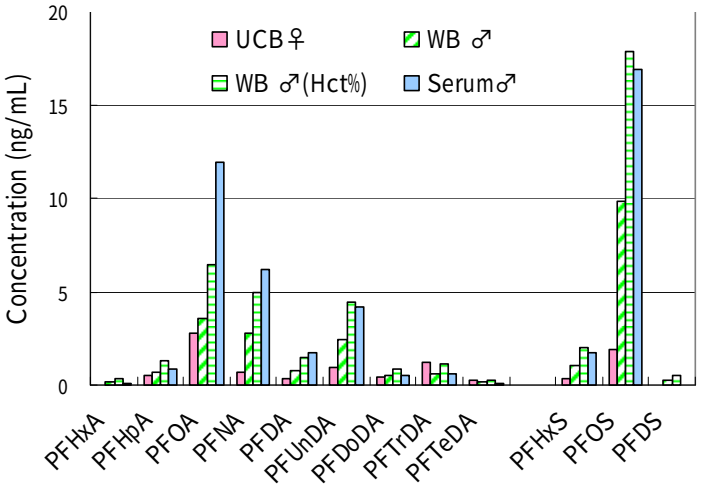
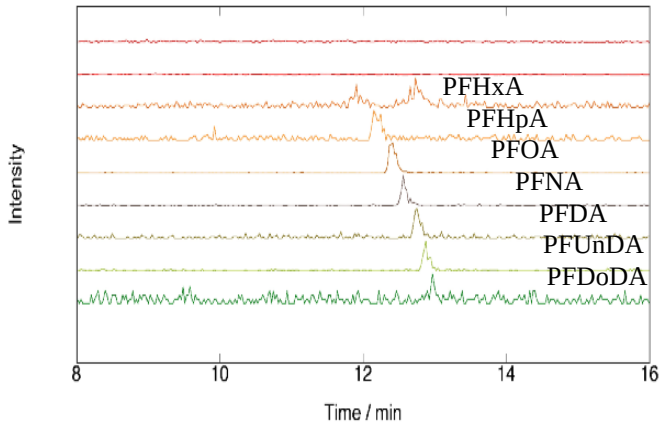


Fig.2 Chromtogram of PFCAs in serum



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