POLYCHLORINATED NAPHTHALENES (PCNs) IN HUMAN ADIPOSE TISSUE IN JAPAN

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Introduction

Polychlorinated naphthalenes (PCNs) are a class of chlorinated aromatic hydrocarbons which have been widely distributed in the global environment[1-3]. There are 75 possible PCN isomers and congeners and the chlorination of naphthalene results in the formation of a complex mixture of individual components[4]. These compounds were employed for use similar to the types of applications as PCBs, i.e. as plasticizers, as heat transfer fluids in heat exchangers, as insulating fluids in electrical equipment and as timber preservatives[5, 6]. Another source was discussed in the recent paper[7]. Production of PCNs have now been discontinued, at least in Europe[8, 9] and Japan[10]. The secondary formation of chlorinated naphthalenes in thermal processes such as municipal waste incineration also suggests sustaining environmental sources of PCNs[10-14]. Some recent toxicological studies have focused on the dioxin-like toxicity of PCNs such as induction of aryl hydrocarbon hydroxylase and ethoxyresorufin-o-deethylase[15, 16]. PCN contamination in humans and wildlife is not well understood. In this study, the isomer-specific profile of PCNs was examined in Japanese human adipose tissue samples. In addition, TEQs were estimated for toxic PCN congeners and compared with those of PCDD/DFs in the same samples to evaluate the relative significance of these compounds.

Materials and Methods

The human adipose tissue samples were obtained at Matsuyama and Osaka Prefectures, Japan. The samples were homogenized with anhydrous sodium sulfate and extracted with dichloromethane. The extract was cleaned up with concentrated sulfuric acid. Fractionation was carried out with activated silica-gel column and alumina columns for PCNs, and additionally charcoal impregnated silica-gel mixture column for PCDD/DFs[17]. HRGC (Hewlett Packard 5890 Series II, USA)-HRMS(JEOL SX102A, Japan) was used for the determination of PCN and PCDD/DF congeners. PCN recoveries through the procedure were as follows: triCNs 80-83%, tetraCNs 75-96%, pentaCNs 76-91%, hexaCNs 63-89%, heptaCNs 103-118% and octaCN 93-103%. TEQs of PCNs residued in human samples were calculated using TEF values of PCNs reported by Blankenship et al. [18]. An equivalent mixture of Halowax formulations (1000, 1001, 1013, 1014, 1031, 1051 and 1099) was used as a standard for quantification[19]. Statistical significance was examined using the Mann-Whitney non-parametric test.

Results and Discussion

Six individual adipose tissue samples from Ehime and fifteen adipose tissue samples from Osaka were analyzed for PCNs. In all the samples analysed, PCN congeners were determined in the range of 3,200 to 10,300 pg/g (fat weight basis) for Ehime samples and 2,020 to 249,000 pg/g for Osaka samples, respectively. These results were comparable with those reported for Canadian[20] and Japanese data[21] on PCN levels in human adipose tissue. Although the small number of samples limits the power of statistical tests, however, a significant difference ($p<0.05$) was found between the levels in samples from Ehime and Osaka. PCN homologue composition in the samples from both regions were also different. It is estimated that this difference is caused by the background levels of PCNs including the habitat and diet.

Table 1. Concentrations (pg/g on fat weight basis) of PCNs, PCDDs and PCDFs in human adipose tissue in Japan.

Sampling region		PCNs	PCDDs	PCDFs
Ehime (n=6)	Max.	10,300	1,100	180
	Min.	3,320	120	35
	Ave.	4,940	410	69
Osaka (n=15)	Max.	249,000	2,200	77
	Min.	2,020	120	30
	Ave.	31,600	1,200	53

On the other hand, the congeners 1,2,5,8-/1,2,6,8-tetra-CN (PCNs 38/40), 1,2,3,5,7-/1,2,4,6,7-penta-CN (PCNs 52/60), 1,2,3,6,7-penta-CN (PCN 54), and 1,2,3,4,6,7-/1,2,3,5,6,7-hexa-CN (PCNs 66/67) were the major components in the samples. The profile of PCN homologues in human was different from those observed in Halowax formulations and in fly ash samples from municipal solid waste incinerators. The PCN congeners determined in human samples might have stable and accumulative properties as reported previously [6, 20].

Concentrations of PCN congeners in human samples were higher than those of PCDD/DFs detected in the same samples. The data showed no correlation of residue levels with donor age and sex for either PCNs and PCDD/DF congeners.

Since PCN congeners are planar compounds with structures similar to PCDD/DFs, they have the dioxin-like toxicities[15, 16, 18]. In recent years, the relative potencies (REP) derived from the H4IIE-luc bioassay as the activity mediated by binding to aryl hydrocarbon receptor has been proposed by Blankenship et al.[18] for several individual PCN congeners. In an attempt to evaluate the toxic implications of PCNs present in human adipose tissues, the 2,3,7,8-TCDD equivalent (TEQs) were estimated for the active PCN congeners on the basis of the potencies relative to 2,3,7,8-TCDD in human adipose tissue samples obtained in Ehime and Osaka, and the contribution of PCN congeners to total TEQs were determined in the samples. As a result, the TEQs estimated for PCNs in human were much less than those for PCDD/DFs.

It is clear that further work is needed on the toxic implication of PCNs present in humans and wildlife as well as the sources of these compounds, because the residue levels may depend on the habitat and diet.

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