CONGENER-SPECIFIC PROFILES OF PCDDs/PCDFs IN BEEF, PORK, AND CHICKEN

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Introduction

The dioxin crisis in Belgium in January 1999 affected Korea's pork importation and led to increased awareness on environmental chemical residues in foods of animal origin in the country. One of the major sources of dioxins (PCDDs/PCDFs) in the environment is combustion [1]. Incineration of waste, including municipal solidwaste, hospital waste and industrial hazardous waste, is probably the most significant combustion source of PCDDs and PCDFs. The potential precursors of dioxins in combustion processes are PCBs, chlorinated phenols, or chlorinated benzenes. However, most dioxin incidents related to food in several countries were through animal feeds. The deposition of emission from incineration has contaminated crops and the ground and built a background level of dioxin in animal feeds [2]. Contaminated citrus pulp, kaolinite clay, and choline chloride premixtures in animal feed also contribute to the high concentration of dioxins in milk, butter, and animal fat [3,4,5]. In the Belgium crisis, the unusual contamination happened in animal feeds through recycled animal fat [6]. Fate of dioxins in the environment and in the food chain affects the congener patterns of residual dioxins in animal origin food [7,8]. The level of PCDDs/PCDFs in dairy milk represented the feeding of locally grown fodder that adsorbed the local atmospheric deposition of PCDDs/PCDFs [7]. The congener characteristic profiles and the background level of dioxins in circulated beef, pork, and chicken from Korean market were investigated in this study.

Methods and Materials

The monitoring of dioxins was conducted on domestic and imported beef, pork, and chicken meat products from January 2001 to December 2002. The domestic samples, which included 38 beef, 48 pork, and 33 chicken, were collected nationwide. The imported samples included 98 beef from 4 countries, 58 pork from 11 countries, and 8 chicken from 4 countries, which were collected from randomly selected foreign countries. Fat was extracted from the samples in the oven under 80^{o}C before analysis. The lipid percent were determined and carbon-13 labeled standards were spiked to the extracted fat. Isotope dilution method was used based on US EPA 1613B protocol. Extraction was carried out with hexane and clean-up was performed using Power-Prep^{TM} (FMS Inc., USA) automated column procedure. The extract was concentrated to 100µl and analyzed by HR-GC/MS (Autospec Ultima, Micromass Co., UK). The capillary column DB5MS (60m x 0.25mm I.D., 025µm film thickness, J&W Scientific, USA) was used for the separation on GC.

Results and Discussion

The congener profiles of PCDDs/PCDFs in domestic and imported beef, pork, and chicken are presented in Figure 1 and Figure 2, respectively. PCDFs were the dominant congeners in domestic beef and pork. In pork, 1,2,3,4,6,7,8-HpCDF was significant. OCDD, however, had the highest concentration in beef and pork samples. The congener profile of PCDFs in beef and pork were similar. The concentration of PCDFs decreased with the increase in the number of chlorine substituted except for 1,2,3,4,6,7,8-HpCDF. Most chicken samples were free of dioxins compared to beef and pork. The frequency of detection for OCDD was about 30% in 33 domestic chicken samples. OCDD also had the highest concentration in chicken. Congeners 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD that have the highest TEF values were not observed in domestic beef, pork, and chicken. Tetra-, penta-, and hexa-chlorinated dioxins were less determined than those homologues of furan. Overall, the distribution pattern of PCDDs/PCDFs in domestic samples was similar in beef and pork. The location where the animals were raised had no major influence on the congener profiles of the meat samples. The results suggested that the sources of PCDDs/PCDFs were almost similar throughout Korea even though the feed stuffs were different.

The distribution patterns in beef and pork were different in the domestic and imported samples. The concentration of 1,2,3,4,6,7,8-HpCDD was higher than OCDD only in the imported beef compared to all the other samples. OCDF in imported beef and pork had higher concentration compared to domestic ones. The concentration of PCDFs in imported pork increased with the increase in the number of chlorine substituted. The frequency of detection for OCDD and 1,2,3,4,6,7,8-HpCDF was about 13% respectively in 8 imported chicken samples. The information of sources or causes that can explain the congener profiles of imported beef, pork, and chicken was not available.

Table 1 summarizes the determined concentrations of PCDDs/PCDFs and their TEQ levels in beef, pork, and chicken. WHO (1998) TEFs were used for the toxicological expression. The concentrations represent the average levels of dioxins in the major consumed meat in Korea. The numbers of domestic and imported samples were 136 beef, 106 pork, and 41 chicken. The concentration of PCDDs/PCDFs were 6.03 pg/g fat, 8.28 pg/g fat, and 0.76 pg/g fat for beef, pork, and chicken, respectively. The concentrations of both PCDDs and PCDFs were higher in pork than beef. In toxicological point of view, the levels of dioxins were 0.17 pg TEQ/g fat, 0.18 pg TEQ/g fat, and 0.002 pg TEQ/g fat in beef, pork, and chicken, respectively. The non-observed 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, and 2,3,7,8-TCDF were contributed to low TEQ relative to absolute concentration determined. The survey in USA showed that the average levels of PCDDs/PCDFs were 0.35 pg TEQ/g fat in beef from the 63 samples and 0.42 pg TEQ/g fat in market hogs from the 56 samples using the International Toxic Equivalence Factor (I-TEFs) scheme [9,10]. It is difficult to compare the determined concentration of dioxins in the samples with previous studies. Almost all samples were different in terms of environmental conditions for livestock and feeding stuffs. Also, the final calculations were different based on the use of the WHO-TEFs or I-TEFs.

Although different isomer profiles were detected and identified according to the kinds of meat and product origins, the toxicological levels of dioxins were very low in circulated beef, pork, and chicken.

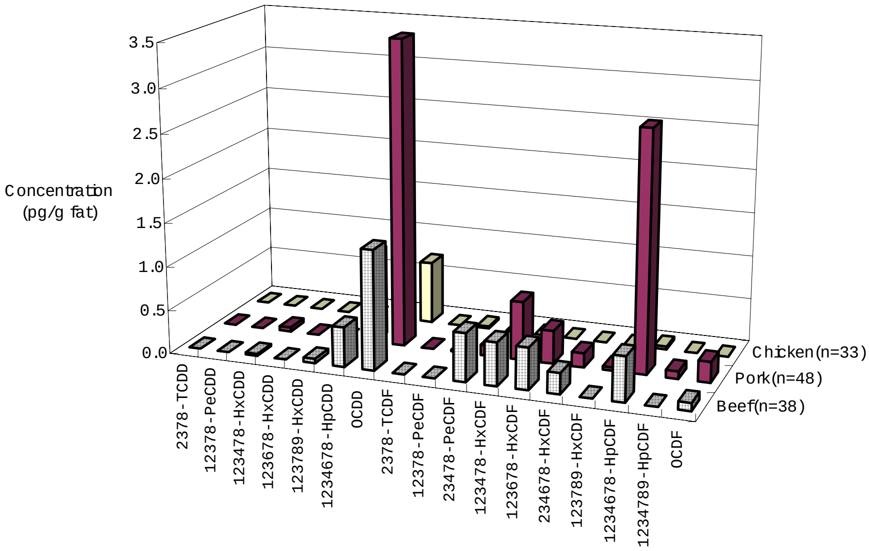

Figure 1. Congener- specific profiles for PCDDs/PCDFs in domestic beef, pork, and chicken.

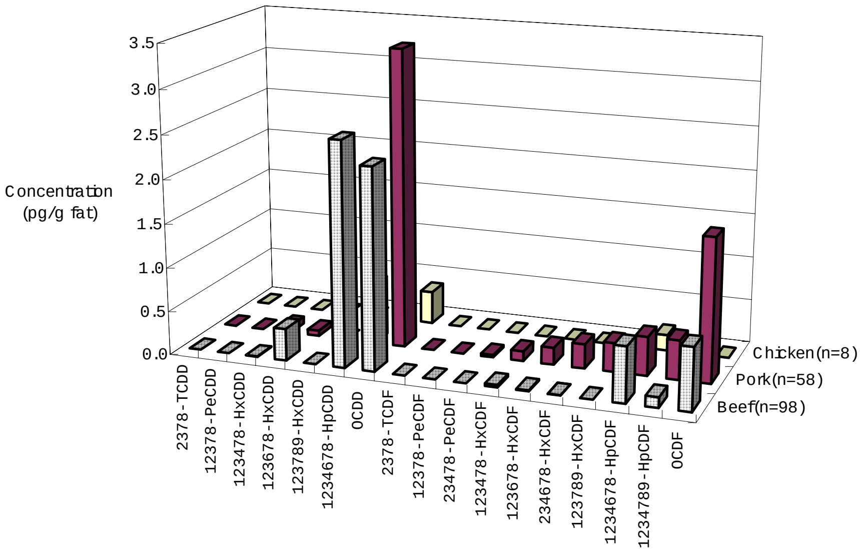

Figure 2. Congener-specific profiles for PCDDs/PCDFs in imported beef, pork, and chicken.
Table 1. Congener-specific concentrations and TEQ levels of PCDDs/PCDFs in the major consumed meat in Korea

Congener	Beef (n=136)	Pork (n=106)	Chicken (n=41)
2,3,7,8-TCDD	nd	nd	nd
1,2,3,7,8-PeCDD	nd	nd	nd
1,2,3,4,7,8-HxCDD	0.01	0.07	nd
1,2,3,6,7,8-HxCDD	0.26	0.03	nd
1,2,3,7,8,9-HxCDD	0.01	nd	nd
1,2,3,4,6,7,8-HpCDD	1.96	0.84	0.04
OCDD	2.03	3.44	0.65
PCDDs	4.28	4.38	0.68
2,3,7,8-TCDF	nd	nd	nd
1,2,3,7,8-PeCDF	nd	0.01	0.02
2,3,4,7,8-PeCDF	0.15	0.07	nd
1,2,3,4,7,8-HxCDF	0.16	0.36	nd
1,2,3,6,7,8-HxCDF	0.14	0.28	nd
2,3,4,6,7,8-HxCDF	0.07	0.23	nd
1,2,3,7,8,9-HxCDF	nd	0.20	nd
1,2,3,4,6,7,8-HpCDF	0.60	1.48	0.06
1,2,3,4,7,8,9-HpCDF	0.09	0.28	nd
OCDF	0.54	1.00	nd
PCDFs	1.75	3.90	0.08
PCDDs/PCDFs	6.03	8.28	0.76
(PCDDs/PCDFs) TEQ	0.17	0.18	0.002

nd = not detected

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