CONTAMINATION STATUS OF ANIMAL FEEDS BY PCDDs, PCDFs AND DIOXIN-LIKE PCBs

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Introduction

Dioxins (PCDDs/PCDFs/dioxin-like PCBs) are widely dispersed in the environment. Those are among the most toxic chemicals implicating in a variety of health effects to animals including humans[1]. It has been concluded that humans are exposed to dioxin-like compounds via diet rather than other exposures. More specifically high portion of exposure is coming from animal fat consumption[2-4]. Therefore, it is an important task to identify the routes that dioxins enter animal fats. This gives not only ascertain the human exposure but also provide insight of the health of farm animals. The animal feed could contain components that may be animal fat products as dietary supplements or other added components. The main objective of this work was to identify and quantify the possible dioxins exposure through animal originated feed supplements and animal fat.

Methods and Materials

Feed supplements, animal feed and fat were collected during year 2001-2002, with some imported ones. They were included with fish oil, fish meal, bone and meat meal, feeds for domestic animals, and pig and chicken fat. All samples were stored at 4 or –20˚C until analysis

These samples were soxhlet extracted with toluene or dichloromethane/hexane. Purification and fractionation were carried out by sulphuric acid, multi-silica gel column and activate carbon column chromatography, respectively. Known amount of ^{13}C-labled PCDDs/PCDFs/PCBs were added as internal standards. Samples were analyzed by HRGC (HP6890, US) with HRMS (Auto Spec-Ultima, Micromass, UK) equipped with a SP-2331column (Supelco, US) and DB-5MS column (J&W Scientific, US).

Results and Discussion

The accumulation pattern of dioxins concentration was in the order of mono-*ortho* PCBs > non-*ortho* PCBs > PCDDs > PCDFs in all the samples analysed. The dioxin-like PCBs concentration was most prominent in fish oil that was up to 20000 pg/g lipid wt (data not shown). In particular, 23’44’5-PeCB and 33’44’-TeCB were detected in great quantities for mono and non-*ortho* PCBs, and found in all samples, respectively. Contamination of dioxins were different among imported and locally produced feed supplements, fish meal and meat and bone meal, however more samples should be analysed for the clear identification.

The calculated TEQs[5] for PCDDs, PCDFs and dioxin-like PCBs are shown in tables 1 and 2. Among the animal originated feed supplements, fish oil showed elevated TEQs (13.5 pg/g lipid wt) level than that from fish meal (1.9 pg/g lipid wt) and bone and meat meal (0.09 pg/g lipid wt). In generally dioxin contamination in fish could be higher than that of domestic animals. This may be the reason for low dioxins contamination in bone and meat meal. More than 60% of total TEQs in animal originated feed supplements were consisted of dioxin-like PCBs with high contributions from the congeners of 33’44’5-PeCB and 23’44’5-PeCB.

Adult chicken feed contained 0.32 pg TEQs/g lipid wt, which was higher than both cattle (0.15 pg/g lipd wt) and pig (0.13 pg/g lipid wt) feeds, respectively. In all the feed samples non-*ortho* 33'44'5-PeCB congener was predominant (Tables 1 and 2). However, contribution of PCDDs, PCDFs and dioxin-like PCBs to the total TEQs of each feed type was different (Fig 1). PCDDs were higher in cattle and pig feeds, however PCDFs were higher in adult chicken feed. The ingredients in animal feed for domestic animals are varied among the species and their growth stage. Earlier it has been reported that high dioxin concentrations were found in animal feeds given in early stage of growth[6].

Table 1. Lipid-based congener specific TEQs (pg/g) of PCDDs and PCDFs in animal feed supplements and animal fat

	Fish oil		Fish meal		Meat and Bone meal		Animal feed			Animal fat	
	1	2	1*	2	1*	2	cattle	chicken	pig	chicken	pig
PCDDs											
2,3,7,8-TeCDD	1.07	0.445	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1,2,3,7,8-PeCDD	0.964	0.597	0.155	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1,2,3,4,7,8-HxCDD	0.060	0.108	0.014	0.014	0.016	n.d.	0.026	n.d.	n.d.	n.d.	n.d.
1,2,3,6,7,8-HxCDD	0.119	0.122	0.018	0.009	n.d.	n.d.	0.019	n.d.	n.d.	n.d.	n.d.
1,2,3,7,8,9-HxCDD	n.d.	n.d.	0.011	0.009	n.d.	n.d.	0.029	n.d.	0.038	n.d.	n.d.
1,2,3,4,6,7,8-HpCDD	0.038	0.033	0.006	0.006	0.007	0.011	0.025	0.014	0.022	0.091	n.d.
OCDD	0.003	0.003	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001
Total PCDDs	2.25	1.31	0.206	0.039	0.023	0.012	0.101	0.015	0.061	0.092	0.001
PCDFs											
2,3,7,8-TeCDF	0.328	0.324	0.079	0.016	0.013	n.d.	n.d.	0.026	n.d.	0.221	n.d.
1,2,3,7,8-PeCDF	0.110	0.087	0.014	0.009	n.d.	n.d.	n.d.	0.017	n.d.	n.d.	n.d.
2,3,4,7,8-PeCDF	0.889	0.909	0.288	0.077	n.d.	n.d.	n.d.	0.068	n.d.	0.738	0.323
1,2,3,4,7,8-HxCDF	0.055	0.081	0.011	0.006	n.d.	n.d.	0.021	0.010	n.d.	0.168	n.d.
1,2,3,6,7,8-HxCDF	0.061	0.079	0.010	0.008	n.d.	n.d.	n.d.	0.016	n.d.	0.052	n.d.
1,2,3,7,8,9-HxCDF	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.038	n.d.	n.d.	n.d.
2,3,4,6,7,8-HxCDF	0.074	0.134	0.014	0.007	n.d.	n.d.	n.d.	0.029	n.d.	0.117	n.d.
1,2,3,4,6,7,8-HpCDF	0.032	0.046	0.006	0.006	0.006	0.012	0.015	0.013	0.021	0.068	n.d.
1,2,3,4,7,8,9-HpCDF	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
OCDF	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n.d.	n.d.
Total PCDFs	1.55	1.66	0.421	0.13	0.02	0.012	0.04	0.217	0.02	1.36	0.323

* Imported n.d.: not detected

Table 2. Lipid-based congener specific TEQs (pg/g) of dioxin-like PCBs in animal feed supplements and animal fat.

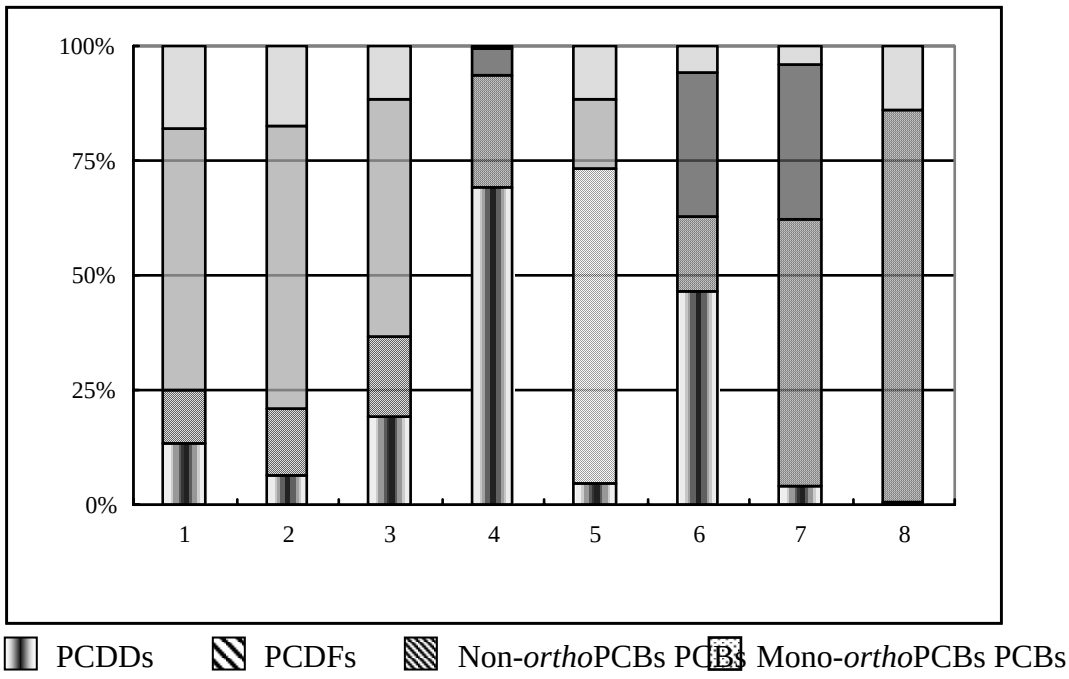
	Fish oil		Fish meal		Bone and Meat meal		Animal feed			Animal fat	
	1	2	1*	2	1*	2	cattle	chicken	pig	chicken	pig
Non-*ortho* PCBs											
344'5-TeCB (#81)	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	n.d.
33'44'-TeCB (#77)	0.015	0.015	0.005	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	<0.001
33'44'5-PeCB (#126)	8.53	6.34	1.86	0.409	0.027	0.064	0.008	0.048	0.039	0.770	n.d.
33'44'55'-HxCB (#169)	0.275	0.209	0.047	0.003	<0.001	0.002	<0.001	0.001	0.001	0.012	n.d.
Total non-*ortho* PCBs	8.82	6.57	1.91	0.41	0.03	0.07	0.01	0.05	0.04	0.785	<0.001
Mono-*ortho* PCBs											
2'344'5-PeCB (#123)	0.214	0.168	0.046	0.008	<0.001	0.001	<0.001	0.002	0.001	0.005	0.001
23'44'5-PeCB (#118)	1.091	0.888	0.219	0.049	0.002	0.008	<0.001	0.019	0.003	0.040	0.018
2344'5-PeCB (#114)	0.131	0.108	0.027	0.002	<0.001	0.001	<0.001	0.002	0.001	0.010	0.005
233'44'-PeCB (#105)	0.362	0.298	0.075	0.027	0.001	0.002	<0.001	0.006	0.001	0.014	0.003
23'44'55'-HxCB (#167)	0.008	0.006	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
233'44'5-HxCB (#156)	0.680	0.534	0.142	0.025	0.001	0.005	0.001	0.006	0.002	0.015	0.020
233'44'5'-HxCB (#157)	0.175	0.137	0.034	0.006	<0.001	0.001	<0.001	0.002	<0.001	0.005	0.005
233'44'55'-HpCB (#189)	0.018	0.012	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Total mono-*ortho* PCBs	2.68	2.15	0.548	0.117	0.003	0.018	0.001	0.037	0.008	0.089	0.054

*Imported n.d.: not detected

The TEQs in animal fat was higher in chicken (2.3 pg/g lipid wt) compared to that of pig (0.38 pg/g lipid wt). Similarly, earlier study showed that dioxins may be accumulated in fat tissues of chicken with the age, however dioxins accumulation was decreased in fattening pig with the age[6]. Composition of total dioxins in chicken fat and adult chicken feed were resembled (Figure 1). PCDFs contributed a higher potion to the total TEQs with the highest concentration of congener 23478-PeCDF (Figure 1 and Table 1). This congener is dominant in all the samples analysed. This suggested that 23478-PeCDF could be one of congener specifically accumulated in animal fat and consequently transferred to human via food chain.

In the conclusion, fish originated feed supplements may contribute high amount of dioxins to the feed. It is been recently reported that fish and fish products are still mainly responsible to human dioxins exposure in Japan[7]. However, domestic meat exhibited higher dioxins than imported ones[7]. It should also be important to know that feed could contain components of plant origin and animals can ingest small fraction of soil, which may be resulted in high tissue levels. More samples should be analysed for differentiate dioxins contamination in domestic and imported feed supplements.

Figure 1. Composition of the total TEQs



1: Fish oil 2: Fish meal 3: Bone and Meat meal 4: Cattle feed
5: Adult chicken feed 6: pig feed 7: chicken fat 8: pig fat

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