LEVELS OF DIOXINS AND PCBs IN COMMERCIAL BABY FOOD

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Introduction

Polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) represent a class of halogenated aromatic compounds that are widespread and exhibit a potential risk for human health. These compounds are of great concern due to their environmental persistence, toxicity and bioaccumulation through the food chain(1). Human exposure to dioxins occurs predominantly via food intake with foods of animal origin usually being the mainly contributors of the dioxin intake.

International recommendations for feeding infants encourage exclusively milk feeding during the first months of life with breastmilk as the feeding choice for babies and infant formulas as an alternative for infants who are not breast fed. Complementary foods are recommended to begin between the ages of 4 and 6 months for the majority of infants and they mainly include cereals, fish and meat among others(2).

Congener specific analysis of 17 toxic dioxins and 7 indicator PCBs were performed by HRGC-MS/MS in a number of commercial baby food samples recommended for feeding children in the first stages of life.

Methods and Materials

Commercial food samples, meat and fish based baby food as the most important baby food of animal origin were acquired from local markets and big supermarkets. The different trades studied were collected between 2004 and 2005 and were selected among the best well-known in Spain. Totally, 50 samples (5 different batches from the same manufacturer) were studied.

For each food category and trade mark adquired, an aggreagate sample (1 kg) was made by mixing proportional incremental samples of 5 different batches from the same commercial trade. Lastly, 10 laboratory samples were made up, 6 of meat based baby food (chicken, beef and lamb) and 4 of fish based baby food (sole and hake).

About 20 grams test portions of samples were mixed with sodium sulphate anhydrous and extracted with acetone-n-hexane (1:1) in an automated Soxhlet extractor. In order to express the results on lipid basis the extracted lipid content was determined gravimetrically after evaporation of the solvents.

For PCDD/Fs analysis, prior extraction, samples were spiked with ^{13}C-PCDD/Fs labelled internal standards. Fat extracted was cleaned-up in a sequence as follows: decomposition with concentrated sulfuric acid, followed by multilayer column and alumina column chromatography. Determination of PCDD/Fs was carried out after adding the internal standard solution.

For the analysis of PCBs, an aliquot of 0.5 g of the extracted fat was dissolved in hexane and purified on partially deactivated alumina chromatographic column. The eluting fraction containing the compounds of interest was collected and concentrated to 0.5 ml. PCBs determination was based on Internal Standard method.

All solvents employed were of Pestiscan grade (Lab-Scan, Dublin, Ireland) and hexane was also glass distilled.

After optimization of the chromatographic optimum conditions, the eluting fractions containing the compounds of interest were analyzed by high resolution gas chromatography (HRGC) coupled to Ion Trap MS/MS (Varian, Saturn 2000 MS/MS). Chromatographic separation was achieved with Varian Factor Four fused-silica capillary column (50m x 0.25 mm ID, 0.25 µm film thickness) with helium as the carrier gas at a linear velocity of

1ml/min in the splitless injection mode (2µl). The quantification of PCDD/Fs was carried by the isotopic dilution method and methodology was validated according to EPA Method 1613[3]. Instrumental limit of detection (LOD) ranged between 0.05 ng/ml for tetra-chloro substituted congeners to 5 ng/ml for OCDF, depending on the specific congener. PCBs methodology was validated according to international recommendations and detection limits for the different PCB congeners were set in 0.5 ng/ml

Results and Discussion

Results of the chemical analysis of PCDD/Fs for baby food analyzed are summarized in Table 1. Contamination was calculated as the TEQ values by multiplying the concentrations with the corresponding WHO-TEFs for each congener. Results are reported on a fat basis (pg per g of fat) and on a whole weight basis (pg per g of product) considering as zero the contribution of each non-detected congeners to the TEQ.

The average values for lipid content determined by soxhlet extraction were 2.24% for fish and 2,87% for meat based baby food.

Table 1. Average results of PCDDs and PCDFs in baby food.

Compound	**Meat based baby food (pg/ g fat)**	**Fish based baby food (pg/ g fat)**
2,3,7,8-TCDD	0.11	0.29
2,3,7,8-TCDF	0.15	n.d
1,2,3,7,8-PeCDD	0.08	n.d.
1,2,3,7,8-PeCDF	0.07	0.11
2,3,4,7,8-PeCDF	0.35	0.11
1,2,3,4,7,8-HxCDD	0.28	0.50
1,2,3,6,7,8-HxCDD	0.49	0.86
1,2,3,7,8,9-HxCDD	1.30	0.86
1,2,3,4,7,8-HxCDF	n.d.	n.d.
1,2,3,6,7,8-HxCDF	n.d.	n.d.
1,2,3,7,8,9-HxCDF	n.d.	n.d.
2,3,4,6,7,8-HxCDF	0.24	n.d.
1,2,3,4,6,7,8-HpCDD	5.65	n.d.
1,2,3,4,6,7,8-HpCDF	0.44	n.d.
1,2,3,4,7,8,9-HpCDF	1.15	n.d.
OCDD	17.70	n.d.
OCDF	n.d.	n.d.
pg WHO-TEQ PCDD/F g^{-1} fat	0.67 ± 0.31	0.57 ± 0.84
pg WHO-TEQ PCDD/F g^{-1} product	0.021 ± 0.012	0.013± 0.018

Dioxin average content was higher in meat based baby food (0.67 pg WHO-TEQ/ g fat) than in fish based baby food (0.57 pg WHO-TEQ/ g fat). Besides, a higher desvest was found in fish (0.84) than in meat based (0.31) baby food.

Concentration of indicator PCBs are summarized in Table 2. Results are presented for the seven indicator congeners, the sum of all of them is also shown. Results are expressed in a fat basis (ng per g of fat) and for the sum of all congeners results are also shown on a whole weight basis (pg per g of product), considering as zero the contribution of each non-detected congener .

Table2. Average results of PCBs in baby food

Compound	**Meat based baby food (pg/ g fat)**	**Fish based baby food (pg/ g fat)**
PCB 28	2.37	0.81
PCB 52	1.58	0.37
PCB 101	0.22	n.d.
PCB 118	0.08	0.09
PCB 138	0.30	n.d.
PCB 153	0.19	0.11
PCB180	0.59	0.11
Σ PCBs (ng / g fat)	5.32 ± 7.58	1.49 ± 1.20
Σ PCBs (ng / g product)	0.15 ± 0.20	0.03 ± 0.02

Average concentration of indicator PCBs in baby food was also higher in meat based baby food (5.32 ng/bg fat) than in fish based baby food (1.49 ng/ g fat). However, in this case a higher desvest was found in meat products which is mainly due to the contribution of one beef sample analyzed with a PCBs content of 20.65 ng/ g fat.

Up to day there are no many studies related to the presence of dioxins in food samples which consider this kind of baby food and is the first publicated in Spain. A study carried out in meat based baby food sold in the United States indicated slightly higher values with a dioxin content ranging from 0.008 to 0.155 pg WHO-TEQ/ g product[(4)]. In our work variation in some of the products was found and so dioxin content was higher in chicken (0.93 pg WHO-TEQ/ g fat) and beef (0.89 pg WHO-TEQ/ g fat) than lamb (0.35 pg WHO-TEQ/ g fat) based baby food as well as in the results obtained in the United States.

On the other hand, PCBs content in meat products was lower in chicken (1.65 ng/ g fat) and lamb (2.86 ng/ g fat) than in beef (11.47 ng/ g fat) and so no correlation has been found between dioxin and indicator PCBs content. Results differ from those found in Spain[(5)] in which higher PCBs content were found in chicken, than in lamb and beef as well as in The Netherlands[(6)] where the presence of indicator PCBs was higher in poultry (32.2 ng/ g fat) than in beef samples (10.6 ng/ g fat). However, we have to consider that other ingredients appart from meat, taking part in the baby food composition, may contribute to the presence of these contaminants in the whole product.

Besides, reults obtained in this study can be compared with those calculated in the United Kingdom in 2004[(7)] in which lower values of 0.2 ± 0.02 pg WHO-TEQ/ g fat for meat based baby food were found.

Fish based baby food results from the United Kingdom were similar to those calculated in this study with a dioxin contamination of 0.6 ± 0.07 pg WHO-TEQ/ g fat. However, PCBs content measured in our study in fish based baby food was lower in comparison with levels found for indicator PCBs in fish and fishery products (fish lean: 2.4 ng / g product; fish prepared: 1 ng/ g product; fish fatty: 31.8 pg/ g product) in The Netherlands[(6)].

Maximum limits for dioxins and dioxin-like PCBs in food have been recently stablished[(8)] but they do not include specific maximum limits for infant food. In any case, concentrations of dioxins in all the the baby food samples analyzed were well within the EU maximum limits for meat (3.0 pg / g fat for lamb and beef; 2.0 pg / g fat for chicken) and fish and fishery products (4 pg / g product). Since no tolerance limit for indicator PCBs in foods has been set by the EU or the Spanish Goverment their toxicological evaluation becomes more difficult.

In conclusion, results of commercial baby food analyzed showed similar dioxin content for both fish and meat based baby food and were comparable to those found in other studies. Levels of indicator PCBs were higher for meat than for fish based baby food. Both, meat and fish baby food showed a lower background contamination below maximum limits stablished for dioxins in food. However, more studies to determine the presence of these pollutants in food for children are recommended and the need exits to a continued monitoring programm.

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