PCDD/F Levels in German Canteen Food

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Introduction

Average daily PCDD/F intake via food has been calculated on the basis of PCDD/F levels in selected food samples and mean consumption habits of the German population. Due to improvements in emission control measures, contamination levels in food have decreased significantly within the past few years. Consequently, daily PCDD/F intake has reached values about 70 pg I-TEQ corresponding to 1 pg I-TEQ/kg body weight in 1995 [1,2]. Measurements of dietary PCDD/F intake by the duplicate method are in good agreement with these results [3, 4].
As an attempt to get actual data on PCDD/F intake we analysed prepared canteen food collected in 1996 and 1997. In Germany, canteens are visited regularly by a great number of people like students, workers and employees for taking a meal, especially lunch. Empirically it has been shown that the average intake of nutritive substances by lunch is about one third of the total intake per day [5]. The aim of the study was to determine the range of PCDD/F levels and I-TEQ intake per meal over a period of one year.

Materials and Methods

Meals were collected daily at a canteen providing lunch for the staff of a hospital in Munich. Samples consisted of soup, meat and vegetables. Drinks, salads and desserts were not included. The meals were homogenised with the use of a meat grinder and aliquots of seven samples were pooled representing mixed week-samples. The composites were stored at – 18 °C. Prior to analysis samples were freeze-dried and crushed with a warring blender. After addition of a mixture of 15 ^{13}C-labelled internal standards samples were extracted with n-hexane/acetone (2+1). Fat contents were determined gravimetrically. Finally, a clean-up with three chromatographic steps (mixed acid-base-silica, charcoal, florisil) was carried out. Determination of PCDD/F was performed by HRGC/HRMS on a AutoSpec Ultima mass spectrometer at a resolution of 10,000 in the selected ion mode. Isomeric specific separation of PCDD/F was carried out on DB5-ms and SP2331 capillary columns. For calculation of I-TEQ values TEFs according to NATO/CCMS were used.

Results and discussion

50 mixed-week samples collected from autumn 1996 to summer 1997 were analysed (two missing weeks in spring 1997). A summery of the results is shown in table 1.

Table 1: summery of results of 50 mixed-week samples of canteen food (lunch)

	mean	median	min	max
fresh weight per meal (g)	597	614	434	689
fat content of meals (%)	3.5	3.4	1.9	5.5
fat intake per meal (g)	21.1	20.3	13.1	34.4
PCDD/F level (pg I-TEQ/g fat)*	0.37	0.36	0.16	0.78
dietary intake per meal (pg I-TEQ)	7.6	7.2	2.4	13.4

* not detected congeners were calculated with half detection limits

The average PCDD/F level was 0.37 pg I-TEQ/g fat. In figure 1 all I-TEQ results are presented over the whole sampling period. I-TEQ values of most samples lay in a narrow range from 0.2 to 0.52 pg/g. Two samples showed elevated PCDD/F contamination with I-TEQ values exceeding 0.6 pg/g. Seasonal trends of PCDD/F levels could not be observed.

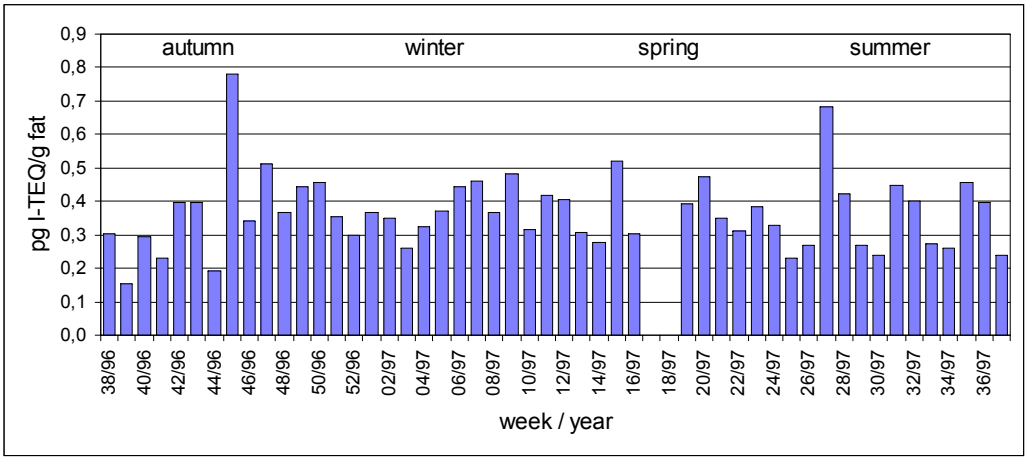

Figure 1: PCDD/F levels in prepared canteen food (pg I-TEQ/g fat)

Dietary intake of PCDD/F per meal was calculated from contamination levels, fat contents and fresh weights of meals. Figure 2 shows the calculated I-TEQ intake per meal over the whole period of sampling. Values ranged from 2.4 to 13.4 pg I-TEQ. The average intake per meal was 7.6 pg I-TEQ. No seasonal trend of dietary PCDD/F intake was observed.

Investigations on contamination levels in food have shown that animal fat is the main source of dietary PCDD/F intake due to accumulation within the food chain [1,2,5,6]. In general, background contamination of plants is low and contribute only little to the amount of ingested PCDD/F. For this reason, it is assumed that the majority of 2,3,7,8-substituted PCDD/F found in canteen food originate from meat and fish.

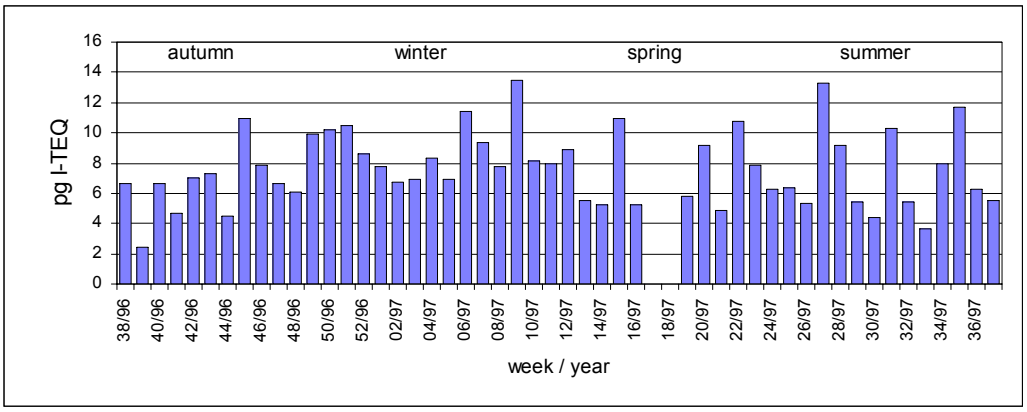

Figure 2: PCDD/F intake per meal (pg I-TEQ)

In the canteen selected for this study the offered meals were clearly dominated by pork (35 % of total numbers of meals) and poultry (22 %), followed by ground meat products and sausages (21 %). Fish was offered once a week (14 %). Beef, game and lamb contributed less than 10 % to the total number of meals. In consideration of these evaluation and the fact that pork often contains more fat than other meat, it is obvious that pork fat was the most abundant animal fat in the analysed mixed-week samples. In addition, vegetable fats and oils used for frying and cooking should be present. Milk fat and lipids from eggs may contribute to the total fat content of meals in small amounts.

In accordance with the expected fat composition the average PCDD/F homologue profile of canteen food (figure 3) was very similar to the profile found in pork. In sample 45/96 which showed the highest I-TEQ value in the study, elevated levels of low chlorinated dibenzofurans, especially 2,3,7,8-TCDF, were found (figure 3). TCDF and PCDF congeners are dominating in fish fat and it is likely that the increased I-TEQ value of this sample is caused by contamination of fish.

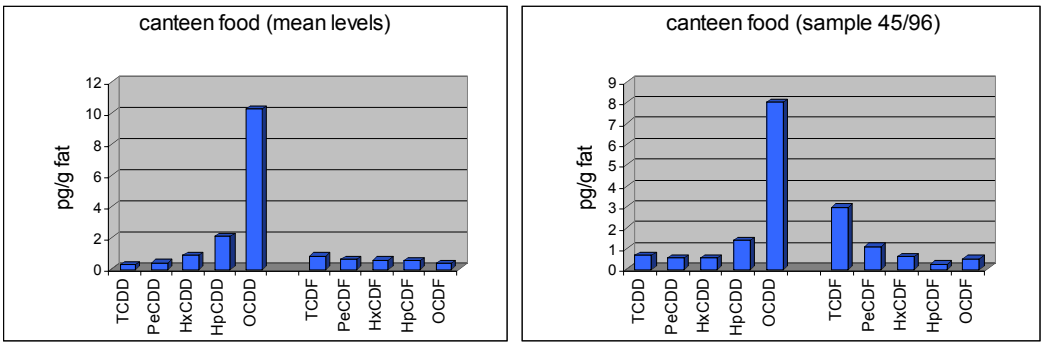

Figure 3: PCDD/F homologue profiles of canteen food (mean levels and sample 45/96)

Normally, in pork and beef no or only very small amounts of non-2,3,7,8-chlorosubstituted congeners are detectable. In poultry and particularly in fish considerable contents of these compounds can be found and in plants the amount of non-2,3,7,8-substituted congeners is relatively high compared to the amount of 2,3,7,8-substituted congeners.
In all samples, analysed in this study, non-2,3,7,8-substituted congeners could be detected. The ratio of the contents of non-2,3,7,8-substituted congeners to the contents of 2,3,7,8-substituted congeners of the corresponding homologue group was significantly higher than in poultry or fish, indicating that these components originate to a great extent from vegetables.

The average fat content of analysed meals (without salad and dessert) was 21 g. This content is in conformity with recommendations on intake of nutritive substances by canteen food, according to which lunch should not contain more that 24 g fat [7]. Statistical evaluations of dietary habits of the German population have shown that the average daily intake of fat is 102 g for male [8]. On the supposition that determined PCDD/F levels in fat, isolated from prepared meals in this study, are representative of total fat consumed by humans (102 g fat/day), the daily PCDD/F intake would amount to a mean value of 36.7 pg I-TEQ and a range from 11.6 to 64.8 pg I-TEQ.

As a limitation of this study, it has to be considered that important types of animal fat like milk fat are not included in the mixed-week samples in representative amounts. On the other hand, PCDD/F contents in food samples from Bavaria in southern Germany, analysed in our institute in 1997 (mean levels [pg I-TEQ/g fat]: pork: 0.25; beef: 0.7; poultry: 0.43; milk: 0.5) have shown that contamination of milk fat is very close to the average contamination of meat.

Despite all limitations, the results of this study indicate that the daily PCDD/F intake is already below 1 pg I-TEQ/kg body weight and that PCDD/F levels in food are decreasing further on.

Acknowledgements

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