Dietary intake of PCDD/F measured by the duplicate method

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Summary

Levels of PCDD and PCDF were determined in 14 food samples which were collected as duplicates. The participants of this study were seven male and seven female persons, aged 24-64 years, living in the Ruhr District of North Rhine-Westfalia, Germany. Sampling time for each food-duplicate was three days. Sampling days were spread balanced over workdays and weekend. All persons kept a record of their food intake including drinks, snacks and drugs.

The PCDD/F-levels in the food-duplicates ranged from 0.24 to 1.3 pg/g I-TE (lipid basis) or 54 to 250 fg/g (dry weight basis), respectively. Daily intake was in the range of 23 to 96 pg/day I-TE or 0.18 to 1.7 pg I-TE/(kg d) and therewith in the range or lower than estimated in the past.

Introduction

It is assumed that more than 90 % of the intake of PCDD/F by humans takes place via food[1]. Dairy products, meat and meat products, and fish and fish products each contribute nearly 30 % to this exposure[2,3,4]. The estimated average daily intake of 2,3,7,8-TCDD and I-TE via food in Germany is 20 and 130 pg/(person d) or 0.3 and 2 pg/(kg d), respectively[4]. These calculations are based upon dietary habits of the German population and includes analyses of selected food samples. The estimations contain possible uncertainties such as incomplete knowledge of the PCDD/F-concentrations in special food items and are based in some cases on a small number of analyzed samples.

More reliable data of the actual individual PCDD/F-intake via food can be obtained from studies with the duplicate method. At this the whole consumed food of individuals is collected as a duplicate and analyzed for PCDD/F. The period and time of collection as well as the number of participants influence the validity of the study.

Methods

14 persons, seven male and seven female, aged 24-64 years, living in the Ruhr District of North Rhine-Westfalia, Germany, participated in this study. Samples were collected between December 1994 and February 1995. Sampling time for each food-duplicate was three days. Sampling days were spread balanced over workdays and weekend. All persons kept a record of kind and amount of their food intake including drinks, snacks and drugs. The record was taken into standardized schedules. The participants received special instructions to fill in the forms. Additionally all persons were asked for personal data, habits of life, food consumption, cultivation and preparation of vegetables or fruits, and other relevant data using a standardized questionnaire.

The participants collected the duplicates in precleaned glasses with screw caps and stored them at home in a refrigerator. The glasses from the previous day were collected by us each morning. The samples were weighed, mashed and homogenized with a blender and the homogenate was frozen at -20°C. After collecting all three samples from each participant the homogenates were mixed together using a handblender. An aliquot of this homogenate, representing a mean foodsample over a three-day-period, was lyophilized. The dried matter was weighed again and stored at -20°C until analysis.

The food analyses were performed in series of 5 samples and 1 blank. About 60 g of the lyophilisate were spiked with 17 $^{13}C_{12}$-labelled PCDD/F-isomers and soxhlet-extracted with toluene:2-methoxyethanol (90:10) for 24 hours. The extract was evaporated at 40°C under vacuum to constant weight. The residue, which represents the fat content, was weighed, redissolved in hexane and cleaned up with standard methods, including several types of modified silicagels and activated charcoal. The purified extract was analyzed by HRGC/HRMS. Detailed analytical conditions were described elsewhere [5].

Results and discussion

The mean ingestion of food including drinks was 2.6 kg/d (range 1.9 - 3.8 kg/d) or 37 g/(kg d) (range 26 - 54 g/(kg d)) on fresh weight basis, and 0.44 kg/d (range 0.33 - 0.61 kg/d) or 6.3 g/(kg d), range (3.4 - 9.4 g/(kg d)) on dry weight basis, respectively. The mean fat consumption was 99 g/d (range 59 - 140 g/d) or 1.4 g/(kg d) (range 0.8 - 2.3 g/(kg d)), respectively.

In all samples both 2,3,7,8-chlorosubstituted and non-2,3,7,8-chlorosubstituted congeners could be detected. The box-and-whisker plots in figure 1 show the mean levels, medians, ranges, 25.- and 75.-percentiles of PCDD/F-homologues on a dose basis. In most cases the PCDD-levels increase with the chlorination grade. OCDD has the highest concentra-

tion of all congeners. Table 1 shows the 2,3,7,8-TCDD- and I-TE-levels of food duplicates each on lipid and dry weight basis and the calculated dietary intake.

Figure 1: Mean levels (+), medians (I), ranges (⊢, —⊣), 25. ([) and 75. (]) percentiles of PCDD/F of the food duplicates on a dose basis [pg/(kg d)]

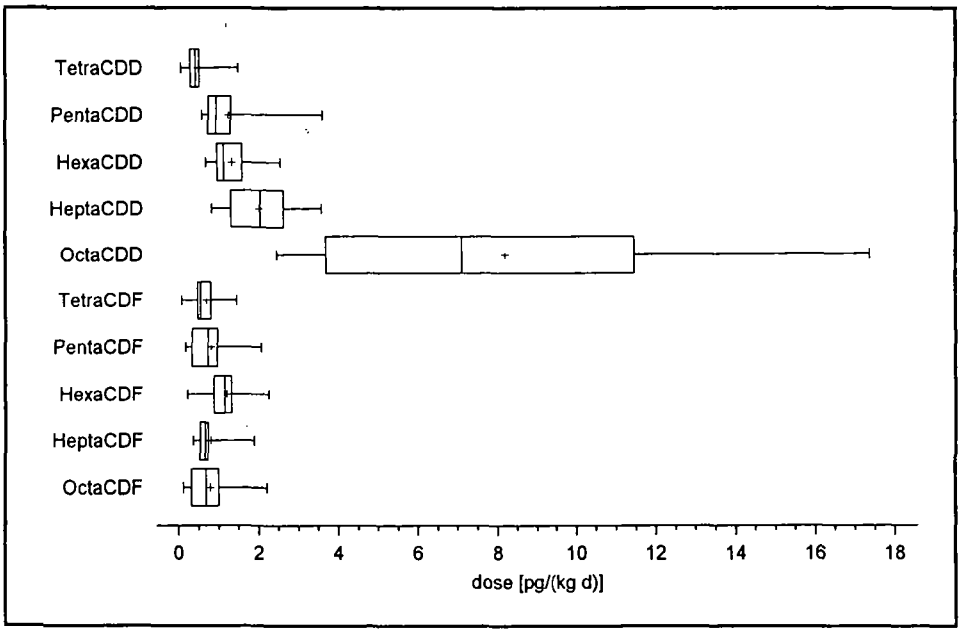

Table 1: 2,3,7,8-TCDD- and I-TE-levels of the food duplicates each on lipid and dry weight basis and the dietary intake

	concentration		dietary intake	
	[pg/g] (fat weight basis)	[fg/g] (dry weight basis)	[pg/d]	[pg/(kg d)]
2,3,7,8-TCDD	0.034 - 0.19	7.7 - 37	3.3 - 14	0.026 - 0.26
I-TE	0.24 - 1.3	54 - 250	23 - 96	0.18 - 1.7

In comparison to the data of Beck et al. (1991)[4] who estimated a mean dietary intake of 20 pg 2,3,7,8-TetraCDD/d and 130 pg I-TE/d or 0.3 pg 2,3,7,8-TetraCDD/(kg d) and 2 pg I-TE/(kg d), respectively, the measured dietary daily intake in this study is lower whereas the mean consumption of fat is the same.

Some of the data of Beck et al. (1991) were measured in the eighties. In comparison to this it is possible that our lower data reflect the efforts to reduce PCDD/F-emissions within the last years. Decreased levels as a time trend over the last years and a possible result of decreased PCDD/F-intake was found in human milk and human blood, too[6,7].

Conclusion

The measured daily intake of PCDD/F from food is in or below the upper range of the tolerable daily intake of 1 - 10 pg I-TE/(kg d), published by the German Federal Health Office (Bundesgesundheitsamt)[8,9,10]. Based on this our data suggest no health risks due to PCDD/F in food. Under the aspect of preventive health care, however, the daily intake of more than 1 pg I-TE/(kg d) is a matter of concern so that further measures are required to reduce the emission of PCDD/F into the environment.

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