EXPOSURE TO PCDD AND RELATED COUMPOUNDS IN INDOOR AIR: A CRITICAL APPRAISAL OF CURRENT RISK ASSESSMENT

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ABSTRACT

Beside the ingestion of fatty food products inhalative exposure to PCDD, PCDF and PCB may contribute to human body burden. Regarding exposure to these compounds in indoor air, a number of various factors as measuring conditions and toxicological aspects have to be considered. Compared to the oral uptake of PCDD and related compounds, current risk assessment may overestimate inhalative exposure to these classes of substances.

INTRODUCTION

Ingestion of food products like milk, eggs, fish and meat is generally accepted to be the main source of exposure to polychlorinated dibenzodioxins (PCDD), dibenzofurans (PCDF) and biphenyls (PCB)[2]. Despite this consensus there is still concern about potential uptake of these classes of substances via inhalation.

Regarding the duration of exposure inhalation of outdoor air and indoor air may be considered separately. Outdoor air can be assessed as being minor important because of generally low concentrations of PCDD, PCDF and PCB and because of short exposure time[2,9,11]. This is also true for certain meteorological situations, e.g., smog periods when higher levels in outdoor air are experienced for a few days or weeks.

Indoor air represents the dominant source of inhalative exposure to PCDD and related compounds. Sources have been described in detail[3,4,6] and will not be listed here.

The objectives of the present study are to evaluate factors which determine the risk of inhalative exposure to PCDD and related compounds in indoor air.

EVALUATION OF RELEVANT FACTORS THAT INFLUENCE EXPOSURE TO PCDD AND RELATED COMPOUNDS IN INDOOR AIR

Measuring conditions

According to the emission characteristics in indoor air and the toxicologic profiles and critical endpoints of toxicity of the PCDD, PCDF and PCB, e.g. carcinogenicity, long-term

measurements should be performed applying realistic conditions of use over one or several days. Ideally, repeated active sampling or so-called passive sampling procedures may be preferably used to meet these requirements. Unfortunately for PCDD and related compounds passive samplers are not available yet.

Due to technical reasons, e.g. noise problems produced by active air samplers, PCDD/PCDF or PCB measurements cannot be easily performed under the condition of a normal use of a room. In public buildings like day-nurseries or schools measurements are usually carried out at weekends or when the rooms are closed. Therefore this procedure is not compatible with the idea of a normal use of a room because it does not reflect a regular ventilation situation. Using a simplified ventilation model to simulate a realistic ventilation rate a reduction by a factor of two can be estimated[9].

Furthermore a warming of the room during the measurement resulting in elevated emissions of PCDD and related compounds cannot be ruled out completely.

As a consequence active air sampling procedures represent worst case conditions and are more likely to reflect an emission situation than that of an immission. This is important for comparing concentrations of PCDD and related compounds in indoor air to those in outdoor air or food because the latter are based on year averaged mean values respectively on an analysis of an average food basket[2].

Most if not all of the immissions of PCDD and related compounds in indoor air refer to certain indoor sources and are strongly dependent on temperature. Examples of this relation are given in [3,4]. As a consequence, selection of temperature conditions far above normal conditions, e.g. to simulate the influence of elevated sun irradiation, has to be considered as a worst case approach and may not be properly used for risk assessment of long term effects.

Duration of exposure

Toxicologically based reference values for PCDD and related compounds, e.g. tolerable daily intake or unit risk values, are exclusively referred to a life time basis. Regarding indoor air this condition may be approximate for exposure to these substances in the indoor air of living rooms[9]. In contrast to this situation exposure to PCDD and related compounds in public buildings like day-nurseries, schools and others is limited to a certain duration. In these cases exposure scenarios can be applied only as fractions of life-time[5,9].

TOXICOLOGICAL ASPECTS

Bioavailability

Assessing the risk by exposure to PCDD and related compounds in indoor air a complete absorption is usually assumed. So far, data of absorption of PCDD from inhalative uptake are scarce. Due to low vapour pressure, high adsorption coefficients and high lipophilicity PCDD, PCDF and PCB tend to be bound to dust particles. The pulmonal resorption rate of inhalable dust showing particle diameters of 0.01 to 5 μm is assessed to be 10 to 50 %[13].

As a consequence it seems more appropriate to use models including reduced broncho-pulmonal deposition and resorption for assessing the internal inhalative exposure to these classes of compounds. This may not hold for lower chlorinated PCDD, PCDF and PCB since analysis of ambient air has shown these congeners to be present at relatively high concentrations in the gaseous phase[7]. Due to various sources mainly higher chlorinated PCDD and PCDF are detected in indoor air while for the PCB the lower chlorinated may significantly contribute to indoor air[3,8].

Toxicological evaluation of congeners

The toxicity of PCDD/PCDF mixtures is generally estimated by using toxic equivalence factors (TEF)[1]. Beside the so-called international toxic equivalence factor concept (ITEF) developed by the NATO CCMS group, several different approaches are still used, e.g. the proposal of the German Federal Health Office (GFHO). While concentrations of PCDD and PCDF in biological matter expressed as ITE or TE(GFHO) differ for a factor of about two this is not true for indoor air. Using ITEFs generally somewhat lower concentrations are estimated.

In the case of PCB or PCN so far no TEFs are available for all relevant congeners[1]. Assessments based only on a few selected congeners may lead to inappropriate results since the known profils of PCBs in indoor air are usually not found in biological samples[3].

SAFETY ANALYSIS

Several authors have reported risk assessment of exposure to PCDD and PCDF in indoor air[2,10,11]. An evaluation of hidden safety factors as shown in Table 1 leads to the result that in relation to food ingestion the former risk assessment may overestimate the contribution of indoor air to the total burden of PCDD and related compounds in man.

Criteria	safety factor
worst case	> 2
absorption rate	2 - 10
TEF	> 2
Duration of exposure[a]	2 - 300

Table 1. Exposure to PCDD and PCDF in indoor air: safety analysis. [a] Details are given in[5,9].

CONCLUSIONS

Despite an enlarging body of data on concentrations of PCDD, PCDF, PCB and other related compounds in indoor air, up to now no general consensus is attained on how to assess this path of exposure. According to the present analysis it is recommended to perform measurement of these substances in indoor air applying realistic conditions of use or simulating appropriate ventilation rate. Recently a general approach for detecting major indoor air pollutants has been published[12].

Beside this aspect all relevant factors concerning exposure to PCDD and related compounds in indoor air like absorption rate, activity pattern should be included in risk assessment.

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