BIOMAGNIFICATION OF PCDDs AND PCDFs IN FISH

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ABSTRACT

The uptake of a mixture of PCDDs and PCDFs from food in fish is investigated during 10 days of dietary exposure. This preliminary experiment is carried out to determine the contribution of the contents of the gastro-intestinal tract to the total fish concentration. When intestines are not removed most PCDD and PCDF congeners are present in the fish samples, even when fishes are fed uncontaminated food 2 days prior to sampling. When intestines are removed only the 2,3,7,8-substituted congeners are detected. Fish concentrations, biomagnification factors, absorption efficiencies and uptake kinetics, calculated after 5 months of exposure will be presented at the symposium.

INTRODUCTION

Hydrophobic organic chemicals accumulate in aquatic organisms by uptake from the water in the gills and by uptake from the food in the gastro-intestinal tract. In general it is accepted that the main route of bioaccumulation of hydrophobic organic chemicals is direct from the water. In general, a linear relationship is established between log Kow and log BCF (bioconcentration factor)(1). However for extremely hydrophobic chemicals with log Kow > 6, the log BCF is lower than that predicted from log Kow. This phenomenon is attributed, among others, to reduced bioavailability of such chemicals, due to their very low aqueous solubilities (2). For these chemicals uptake from the food, a proces often referred to as biomagnification, may be of greater importance. However, it is not known to what extent PCDDs and PCDFs are accumulated from food in fish. As part of a study of the bioavailability of PCDDs and PCDFs in the aquatic environment, the uptake of a mixture of PCDDs and PCDFs from food is investigated.

There are different theories about the extent to which biomagnification occurs. One theory suggests biomagnification does occur in the food chain, which can be supported by publications on field and laboratory data (3). On the other hand on the basis of the theory of partion processes, real biomagnification should not occur. According to this theory the biomagnification factor will not exceed unity when expressed on a lipid

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weight basis. This theory is also supported by several publications (4). Many factors may cause variations in results of biomagnification experiments, for instance feeding rate, temperature, duration of the experiment, body lipid contents during the experiment, concentrations based on wet weight instead of lipid weight or contribution of the contents of the gastro-intestinal tract. Therefore it is necessary to describe experimental circumstances and procedures in detail.

In this paper the results of a preliminary experiment on the biomagnification of PCDDs and PCDFs in guppies are discussed. Because only genuine absorption in the body tissue is of interest when studying biomagnification, the importance of removing the gastro-intestinal tract prior to analysis is investigated. At the symposium the results of a long term experiment on dietary exposure will be presented.

MATERIALS AND METHODS

Chemicals

PCDDs and PCDFs are extracted from fly ash collected from the precipitator of a municpal incinerator. The extraction and purification procedure is described elsewhere (5). Nanograde solvents are used.

Food

Contaminated food is prepared by adding the fly ash extract in hexane to commercial dry fish food (Tetramin). Hexane is evaporated under a gentle nitrogen stream.

Exposure

Two year old guppies (*Poecilia reticulatus*) are fed twice a day 1% w/w during 10 days. They are fed twice a day to prevent watercontamination by food residues. Furthermore, the water is filtered over activated carbon to remove PCDDs and PCDFs eliminated by the fish. The experiment is carried out in duplicate.

Sampling and analysis

Before sampling, three guppies are separated and fed uncontaminated food for two days. After the fishes have been killed in liquid nitrogen, the gastro-intestinal tract is removed and analysed separately. A mixture of 10 ^{13}C PCDDs and PCDFs is added to the samples prior to extraction with toluene for 24 hours. The clean up procedure existed of silica/concentrated

H_2SO_4 and basic alumina (6). The final fish extracts are quantified by GC-MSD analyses.

RESULTS AND DISCUSION

Except for 2,3,7,8-TCDF, no TCDDs and TCDFs are detected in fish samples, therefore, these congeners are not discussed. OCDF is not analysed. In samples without intestines only the toxic 2,3,7,8-substituted congeners are detected, while in whole fish samples most other congeners can also be detected. The lipid weight based concentration is lower in samples without gastro-intestinal tract. This is illustrated in Tabel 1 for the H_6CDD and H_6CDF congeners.

Tabel 1: FISH CONCENTRATION AFTER 10 DAYS OF DIETARY EXPOSURE.

Compound	Fish concentration with gastro-intestinal tract. (pg/g lipid)		Fish concentration without gastro-intestinal tract (pg/g lipid)
Sample	A	B	C
H_6CDD			
124679	4400	5500	n.d.[1]
123679	4720	3900	n.d.
123478*	2278	1667	680
123678*	2967	2667	1460
123789*	4456	3033	n.d.
H_6CDF			
123468	800	n.d.	n.d.
124678	1656	1500	n.d.
134678	1233	833	n.d.
123478*	2100	1967	n.d.
123678*	2844	2050	1320
123467	1055	n.d.	n.d.
234678*	2189	1878	n.d.

[1] n.d. = not detected
detection limit is ca.650 pg per sample
* = 2,3,7,8-substituted congeners

These results indicate that non 2,3,7,8-substituted congeners are not retained in the adipose tissue and that their presence in the samples with gastro-intestinal tract is due to the contents of the gut. This demonstrates the importance of removing the gastro-intestinal tract, because otherwise a severe contribution of PCDDs and PCDFs in the gastro-intes-

tinal tract to the whole fish concentration occurs, even when fishes are fed uncontaminated food during 2 days prior to sampling. This will be further verified since the levels measured in the present samples were near the detection level.

The results presented here are preliminary results of a pilot experiment. Fish concentrations, uptake kinetics, biomagnification factors and absorption efficiencies of a mixture of tetra- to octa- chlorinated PCDDs and PCDFs, calculated after 5 months of dietary exposure will be presented at the symposium.

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