DIOXINS AND OTHER POPS IN BY-PRODUCTS, RECYCLATES AND WASTES AND THEIR POTENTIAL TO ENTER THE FOOD CHAIN

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Introduction

The contamination of by-products, recyclates and wastes and their industrial use as raw material in the feedingstuff industry may cause increased levels of persistent organic pollutants in industrially produced compound feedingstuffs. Specific raw materials may contribute an important amount to the human total POPs exposure via the food chain[1]. Only limited information is available about contamination levels and mechanisms leading to contamination of industrially produced feedingstuff with dioxins and PCBs.

A study has been launched by the European Commission (Directorate-General Environment) to evaluate the current data situation concerning PCDD/Fs and other POPs in wastes and their fluxes into feedingstuff[1]. The present paper is related to the follow-up study "Dioxins and other POPs in by-products, recyclates and wastes and their potential to enter the food chain". The study has been launched in 2001 and is based on results of the previous study. It aims to close existing data gaps and – where this would not be possible – to develop an efficient sampling strategy for an appropriate monitoring of process step levels and output levels of various wastes, by-products and recyclates that are used as components in compound feedingstuff. The results shall provide information that allows to determine to which extent the elimination of certain contaminated wastes entering the food chain via feedingstuff might reduce the overall human daily intake of PCDD/PCDFs and other POPs as a decision base for related political action.

Materials and methods

In the preceding study the following four material flows into compound feedingstuff industry have been identified as potentially most relevant for the PCDD/F fluxes into the food chain: (1) olive pulp, (2) used oils and fats, (3) agricultural and industrial wastes with a high fibre content and (4) animal waste.

In order to estimate the TEQ contributions from these "risk-materials" via compound feedingstuff in the human food chain, a material flow analysis has been carried out on the basis of

- information about volumes of relevant materials entering compound feedingstuff industry (top-down and bottom-up approach)
- collection of available data on PCDD/F and dioxin-like PCB contamination levels of relevant materials and materials that allow corresponding conclusions and estimations

On the basis of the results an estimation of the WHO-TEQ contribution of the "risk-materials" into compound feedingstuff and finally to human intake is possible. The importance of the WHO-TEQ input into compound feedingstuffs can be expressed as "contamination volume" (average contamination level x amount used for compound feedingstuff = contamination volume in g WHO-TEQ/a).

Available contamination data have been combined with the figures for amounts used for compound feedingstuff in EU Member States resulting from the material flow analysis. Due to knowledge gaps on volumes and contamination levels the resulting contamination volumes contain considerable uncertainties. However it is possible to assess the importance of specific material flows on the basis of available data and the "contamination-volume-categories" with low, medium and high importance corresponding to 0 to 0.1g, >0.1 to 1.0 g and >1.0 g annual WHO-TEQ input into compound feedingstuff.

The resulting contamination-volume-categories can be applied as an indicator for the importance of WHO-TEQ input into compound feedingstuff industry in the Member States. Consequently it has direct consequences on the need for action (e.g. sampling, monitoring of processes) in order to create reliable knowledge as a decision basis for strategies to reduce the WHO-TEQ freight in compound feedingstuffs.

On the basis of the results a monitoring strategy has been developed taking into account:

- available data on volumes of relevant materials entering the European compound feedingstuff industry
- available process specific data and known contamination levels and contamination theses
- representativity at European scale
- economic efficiency due to the focus on most important materials and a pooled sample approach
- specific sampling for accidental and typical contamination

Results and discussions

On the basis of available data for by-products, recyclates and waste from the investigated materials that are used as industrial feed components This approach leads to the following estimations:

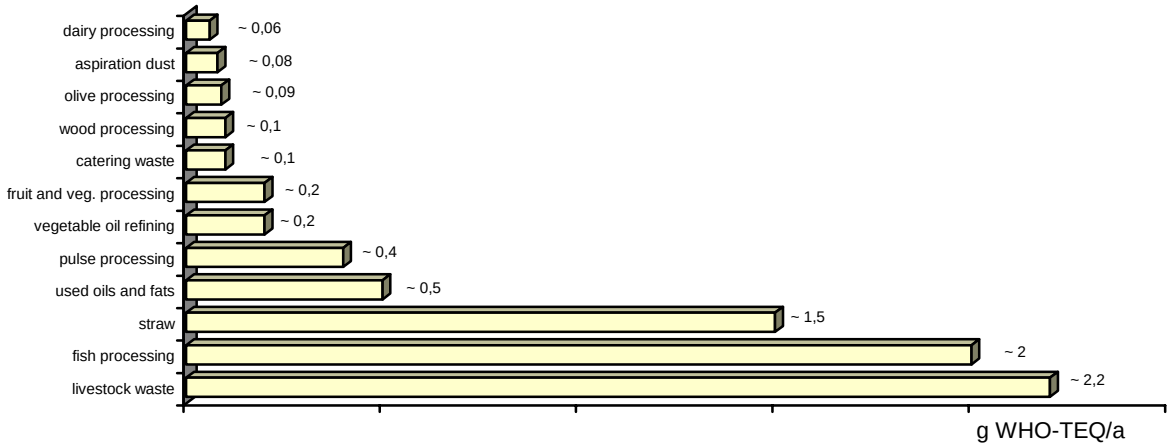

Figure 1: Estimations for WHO-TEQ inputs via the investigated components [g/a]

As a result it can be assumed that an annual WHO-TEQ load up to ~10 g may result from the recovery of wastes, by-products and recyclates. These contaminations are upper bound estimations for the background pollution. Accidents or fraudulent action may cause significantly increased freights. It should be noted that the estimation represents the current status of use of recycled materials. The amount of those materials incorporated in compound feedingstuff may increase due to the political objective to close material circles in order to save resources.

Figure 2 shows, up to 3.3 g WHO-TEQ from the total of 10 g resulting from the background contamination of by-products, recyclates and wastes may at present enter the food chain via food and thus contribute up to 1/6 to the human intake. Consequently, a reduction of the freight from a certain waste stream of 1 g WHO-TEQ/a would reduce the human intake about 0,17 g per year.

This rough estimation is based on the following assumptions:

- The average contamination of compound feedingstuffs has been assessed to be around 0.2 pg/g PCDD/F-TEQ ([2]) or slightly above (0.266 pg/g; [1]). Assuming a comparable contribution from dioxin-like PCBs, a total WHO-TEQ load of 60 g TEQ in feedingstuffs is a reasonable estimation (corresponding to 0.48 pg WHO-TEQ average contamination of feedingstuffs).
- Comparatively little is known about transfer rates of WHO-TEQs from feed to food. Carry over rates from feed to milk are about one third for PCDD/Fs ([1]). Based on this limited knowledge a rough estimation for an overall WHO-TEQ transfer rate from feed to food of 1/3 has been assumed on basis of the PCDD/F data for milk, being aware of a possible underestimation of the total carry over due to a possible higher carry over for persistent PCBs ([3]) or by focusing only on the milk pathway and not considering e.g. storage in animal tissue.
- The average human daily TEQ intake via food in Europe can be assumed to be 63 pg/d from PCDD/Fs plus 83 pg/d from dioxin-like PCBs (arithmetic mean values for adults or total population of SCOOP data[4]). This would result in a WHO-TEQ of 146 pg/d or an annual intake of the total EU Member State population of roughly 20 g WHO-TEQ intake.

- The TEQ-contribution to human intake from recycled materials may be underestimated according to the thesis that the bio-availability of the 10 g WHO-TEQ input from recycled materials may be higher than that from other raw materials. The thesis is based on the consideration, that this share of TEQ contribution has usually already been metabolised and consequently consists of bio-available congeners. In contrast, the 50 g WHO-TEQ input from other raw materials are to a large degree due to atmospheric deposition and contain a higher share of less bio-available congeners resulting in a lower transfer rate in livestock production.

Contamination data have been collected and summarised systematically. Available data show significant deficits in some areas (such as components with high fibre content) some other material flows are quite clear (e.g. fish and fish products, rendered fat). However, there remain considerable uncertainties with respect to the share of PCBs and PCDD/Fs for contamination levels. Consistent process specific data that are essential to draw conclusions on contamination/elimination mechanisms are seldom available. Furthermore for no category of feedingstuff inputs representative contamination data exist at European scale. It has to be concluded that with respect to contamination data a sufficient decision basis for specific and effective political measures hardly exists and consequently further research and data collection is necessary.

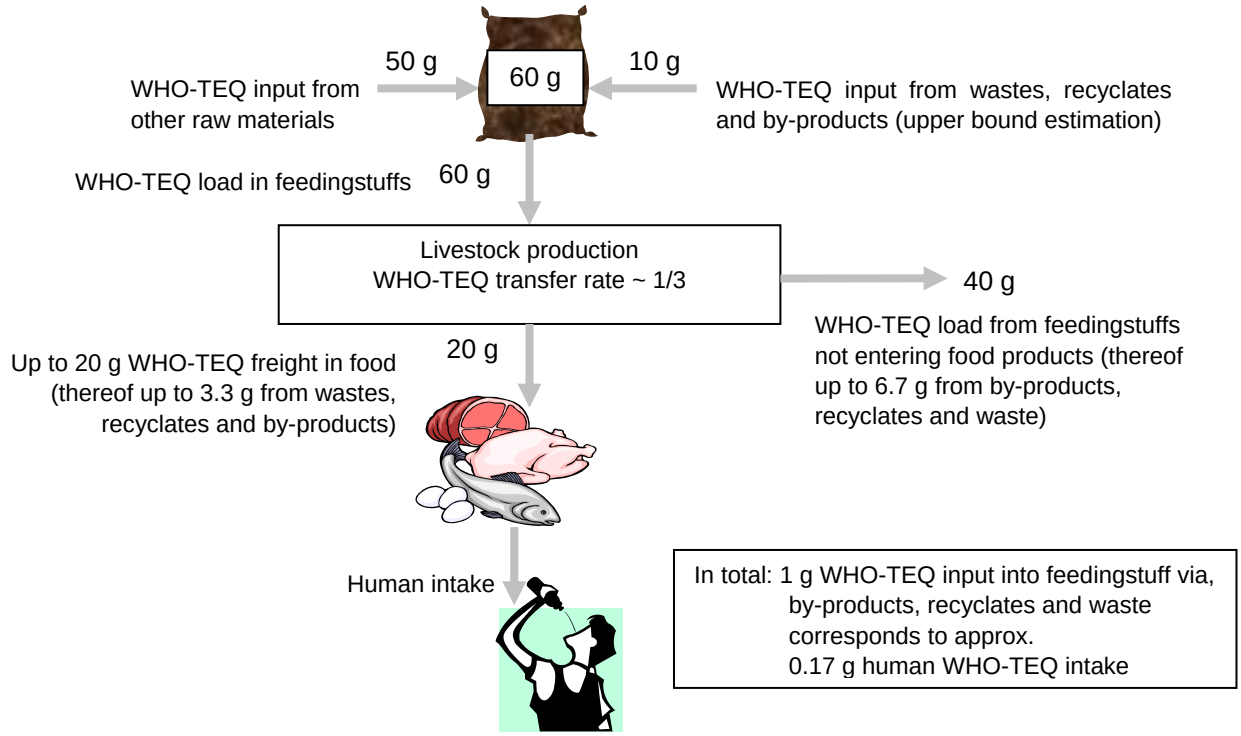

Figure 2: Upper bound estimation on the contribution to the human WHO-TEQ intake from wastes, recyclates and by-products used for compound feedingstuff production

On the basis of the contamination volume categories, the importance of specific material flows contributing to the fluxes into the human food chain can be assessed:

Process	Components	Contamination volume category
Olive processing	▪ olive pulp ▪ non edible olive oil	low
Fat recycling	▪ used oils and fats	medium
Livestock waste	▪ rendered fat	high
	▪ fish meal from fish waste ▪ fish oil from fish waste ▪ fish silage from fish waste	medium high medium
	▪ components from dairy products	low
Agriculture and industry components with high fibre content	▪ straw from grain ▪ harvest residues pulse cultivation ▪ aspiration dust from cereal cleaning ▪ wood processing by-products	high medium low medium
Other components	▪ catering waste ▪ vegetable oil refining by-products ▪ fruit and vegetable processing by-products	medium medium medium

Table 1 contamination volume categories of investigated material flows

These results enable an efficient collection of contamination data. It can be concluded that a general research and data collection programme for all feedingstuff inputs is not necessary. It is much more efficient to collect data in a two step procedure with a first step that is process specific and that enables to determine which and how many output based samples are required to provide representative information at a large scale. These samples can be taken in the second step and are analysed on the basis of a pooled sample approach.

As a result of the present data availability and the importance of material flows, a detailed sampling plan on a European wide scale has been developed. The sampling plan focuses on seven individual feedingstuff components and results in approximately 60 process specific samples and about 180 output based samples that are pooled on the basis of nearly 2400 individual samples).

Taking into consideration the availability of data on the one hand and the importance for the input into the human food chain, a sampling strategy for the efficient and objective driven creation of further data should take into account the following considerations:

- The higher the contamination volume category, the more samples are required
- The sampling strategy should not only aim at the analysis of new samples, but also at the integration of unpublished contamination data to an European database.
- It is essential to start sampling in a first stage with process specific samples and to define on the basis of the results the type of output based samples to be collected in a second stage
- Output based samples should be representative at European scale. A pooled sample approach can significantly lower measurement costs and guarantee representative results.
- Furthermore it is recommended to apply different pooled sample approaches, depending on the question whether typical contamination or accidental contamination is the matter of sampling.

The following measures and recommendations may lower the danger of accidental or fraudulent contaminations as well as improve the European wide standardisation of feedingstuff quality. The project team sees these proposals as a contribution to further discussion and political activities. However a detailed evaluation of the suggestions could not be carried out within the project scope.

- Establishment of a positive list of wastes that are used in feedingstuffs
- Implementation of declaration duties for wastes that are used for feedingstuffs
- Development and implementation of an unequivocal waste identification procedure for feedingstuff inputs
- Separation of handling for materials destined for feedingstuffs and hazardous waste or potential POP-containing waste.
- Licence and quality assurance for suppliers to feedingstuff industry
- Co-ordinated inspection programmes

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