FROM DIOXINS AND PCBs IN FEED AND FOOD TO HUMAN BIOMONITORING OF POPs

Rainer Malisch [1], Alexander Kotz [1], Kerstin Wahl [1], Karin Kypke [1], Angelika Tritscher [2], Katarina Magulova [3] and Heidelore Fiedler[4]

[1] State Institute for Chemical and Veterinary Analysis of Food, Bissierstrasse 5, D-79114 Freiburg, Germany, (EU Reference Laboratory for Dioxins and PCBs in Feed and Food and WHO / UNEP Reference Laboratory for POPs in Human Milk)
[2] World Health Organization (WHO), Department of Food Safety and Zoonoses, 1211 Geneva 27, Switzerland
[3] United Nations Environment Programme (UNEP), Stockholm Convention Secretariat, International Environment House, CH-1219 Châtelaine, Geneva, Switzerland
[4] United Nations Environment Programme (UNEP), Division of Technology, Industry and Economics, Chemicals Branch, chemin des Anémones 11-13, CH-1219 Châtelaine (GE), Switzerland

PCDDs and PCDFs ("dioxins") can be formed as unintentional by-products in a number of chemical processes as well as in almost every combustion process. PCBs are intentionally produced chemicals, that were manufactured for decades before the ban in marketing and use was adopted in 1985. In the 1980ies/early 1990ies, a number of measures were taken to detect possible sources for these contaminants and to stop or reduce their release into the environment.

During the 1990ies, the food chain got into the focus with several incidents, in particular the Belgian dioxin crisis caused by a feed additive heavily contaminated with PCBs ([1]), the contamination of citrus pulp pellets as a result of use of heavily contaminated lime ([2]) and the contamination of clay used as feed additive ([3], [4], [5]). This led to the re-evaluation of the safety of food with regard to dioxin intake by the Scientific Committee on Food (SCF) of the European Commission ([6], [7]) and by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) ([8], [9]). SCF derived a tolerable weekly intake (TWI) of 14 pg 2,3,7,8-TCDD/kg bw, JECFA a provisional tolerable monthly intake (PTMI) of 70 pgWHO-PCDD/F-PCB-TEQ/kg bw.

In 2001, the European Community developed a strategy for dioxins, furans and PCBs for a better protection of human health and of the environment from the effects of dioxins and PCBs ([10]). The integrated and systematic approach is based on two pillars:

1) reduction of the presence of dioxins and PCBs in the environment;
2) reduction of the presence of dioxins and PCBs in feed and food.

Food of animal origin is a predominant source of human exposure to dioxins and PCBs. As food contamination is directly related to feed contamination, an integrated approach is followed to reduce dioxin/PCB incidences all along the food chain, i.e. from feed materials through food-producing animals to humans. These legislative measures concerning feedingstuffs and foodstuffs consists now of two pillars:

1. the establishment of maximum levels at a strict but feasible level in food ([11]) and feed ([12]),
2. the establishment of action levels acting as a tool for "early warning" of higher than desirable levels of dioxins in food ([13]) or feed (see 12).

Tendencies for reduced levels in the food chain can be observed. Remaining problems are caused by incidents, in particular contamination of feedingstuff, and by elevated levels in some kinds of food of animal origin, in particular if environmental levels might contribute to the dioxin intake of animals (in addition to the intake of feedingstuff).

The identification of sources for contamination of the food chain with levels of dioxins and PCBs above maximum levels is difficult and complex. These contaminants are not intentionally used and leave producers helpless when asked for possible reasons of findings of elevated levels in their products. Furthermore, the pattern can change from the original source in particular via feedingstuff to food of animal origin as result of the bioaccumulation.

Of particular interest is the bioaccumulation in humans. Since 1987 the World Health Organization (WHO) has carried out global surveys on the concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and biphenyls (PCBs) in human milk. The first WHO-coordinated exposure study took place in 1987-1988 ([14]), the second round in 1992-1993 ([15]) and the third round in 2000-2003 ([16]).

These studies fulfil important requirements for biomonitoring as requested by the Stockholm Convention on Persistent Organic Pollutants (signed in 2001 and entered into force in 2004) ([17]).The objective of this Stockholm Convention is to protect human health and the environment from POPs (initially twelve important POPs, among them PCDDs, PCDFs and PCBs) by reducing or eliminating their releases.

For the evaluation of the effectiveness, human milk was chosen as one of the two core matrices to be monitored under the Stockholm Convention. Therefore, it was agreed to expand the studies for inclusion of the Stockholm Convention POPs and to perform the WHO human milk surveys in close collaboration with United Nations Environment Programme (UNEP) and the Stockholm Convention Secretariat. Thus, the fourth round in 2005–2007 and the since 2008 following continuous studies were organized as joint WHO/UNEP studies. A comprehensive protocol was developed for collection of representative samples, handling and analysis of samples ([18]).

The global WHO/UNEP-coordinated exposure studies on levels of POPs in human milk contribute to the evaluation of the effectiveness of the Stockholm Convention and allow to derive conclusions on setting of priorities in countries / regions, also with regard to levels of PCDD/Fs and PCBs.

69 countries participated between 2000 and 2012 submitting 174 pooled (= mixed representative) samples. 15 countries participated twice in this period, two countries in triplicate. Large global and regional differences with respect to contamination of human milk with different POPs were found ([19], [20], [21]). Indications were found that also use of clay during pregnancy can cause elevated levels of dioxins in human milk from certain African countries ([22]). Time trends can be derived for countries with repeated participation over time. An updated comprehensive report was presented at the Conference of the Parties (COP) to the Stockholm Convention on Persistent Organic Pollutants (Sixth meeting, 28 April–10 May 2013, Geneva, Switzerland) ([23]) giving an overview of the complex picture.

References

1 Broeckaert F and Bernard A (2000) Polychlorinated biphenyls (PCBs) and dioxins (PCDD/Fs) in the Belgian contaminated food chain: sources, profiles and correlations. Final report, Brussels: Federal Ministry of Agriculture

[2] Malisch R (2000) Increase of the PCDD/F-contamination of milk, butter and meat samples by use of contaminated citrus pulp, Chemosphere 40: 1041 - 1053

[3] Rappe C, Bergeck S, Fiedler H, Cooper KR (1998) PCDD and PCDF contamination in catfish feed from Arkansas, USA, Chemosphere 36: 2705 - 2720

[4] Ferrario J, McDaniel D, Byrne C (1999) The isomer distribution and congener profile of polychlorinated dibenzo-p-dioxins (PCDDs) in ball clay from the Mississippi Embayment (Sledge, Mississippi) Organohalogen Compd 40: 95 - 99

[5] Jobst H, Aldag R (2000) Dioxine in Lagerstätten-Tonen. Z. Umweltchem. 12: 2 - 4

[6] European Commission, Scientific Committee on Food (2000) Opinion of the SCF on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food, SCF/CS/CNTM/DIOXIN/8 Final of 23 November 2000

[7] European Commission, Scientific Committee on Food (2001) Opinion of the SCF on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food, Update based on new scientific information available since the adoption of the SCF opinion on 22 November 2000, CS/CNTM/Dioxin/20 final, adopted on 30 May 2001

[8] R. Canady, K. Crump, M. Feeley, J. Freujer, M. Kogevinas, R. Malisch, P. Verger, J. Wilson and M. Zeilmaker (2002) Polychlorinated dibenzodioxins, polychlorinated dibenzofurans, and coplanar biphenyls, WHO Food Additives Series 48 “Safety evaluation of certain food additives and contaminants, prepared by the fifty-seventh meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA), IPCS (International Programme on Chemical Safety), World Health Organization, Geneva, 2002, p. 451 – 664

[9] World Health OrganizsationWHO (2002) Technical Report Series 909, Evaluation of certain food additives and contaminants, fifty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives

[10] Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee: Community Strategy for Dioxins, Furans and Polychlorinated Biphenyls, Official Journal of the European Communities, 17.11.2001, C 322/2

[11] COMMISSION REGULATION (EU) No 1259/2011 of 2 December 2011 amending Regulation (EC) No 1881/2006 as regards maximum levels for dioxins, dioxin-like PCBs and non dioxin-like PCBs in foodstuffs, Official Journal of the European Union L 320/18

[12] COMMISSION REGULATION (EU) No 277/2012 of 28 March 2012 amending Annexes I and II to Directive 2002/32/EC of the European Parliament and of the Council as regards maximum levels and action thresholds for dioxins and polychlorinated biphenyls , Official Journal of the European Union L 91/1

[13] COMMISSION RECOMMENDATION of 23 August 2011 on the reduction of the presence of dioxins, furans and PCBs in feed and food (2011/516/EU) Official Journal of the European Union L 218/23

[14] Environmental Health Series No 34 (1989): Levels of PCBs, PCDDs, and PCDFs in breast milk, WHO Regional Office for Europe, Copenhagen, Denmark.

[15] Environmental Health in Europe No. 3 (1996): Levels of PCBs, PCDDs and PCDFs in human milk: Second round of WHO-coordinated exposure study, WHO Regional Office for Europe, Copenhagen, Denmark

[16] Rainer Malisch and FX Rolaf van Leeuwen (2003) Results of the WHO-coordinated exposure study on the levels of PCBs, PCDDs and PCDFs in human milk, Organohalogen Compounds 64: 140 – 143

[17] Stockholm Convention on Persistent Organic Pollutants (POPs), http:www.pops.int

[18] WHO (2007) WHO protocol Fourth WHO-Coordinate Survey of Human Milk for Persistent Organic Pollutants in Cooperation with UNEP Guidelines for Developing a National Protocol, Revised 1 October 2007, Department of Food Safety and Zoonoses, World Health Organization, Geneva http://www.who.int/foodsafety/chem/POPprotocol.pdf

[19] UNEP, Status report on the human milk survey conducted jointly by the Secretariat of the Stockholm Convention and the World Health Organization, Conference of the Parties of the Stockholm Convention on Persistent Organic Pollutants, Fourth meeting, Geneva, 4–8 May 2009, UNEP/POPS/COP.4/INF/31

[20] Rainer Malisch, Karin Kypke, Alexander Kotz, Kerstin Wahl, Nicole Bitomsky, Gerald Moy, Seongsoo Park, Angelika Tritscher, Seoung Yong Lee, Katarina Magulova and Heidelore Fiedler (2010) WHO/UNEP-coordinated exposure study (2008-2009) on levels of Persistent Organic Pollutants (POPs) in human milk with regard to the Global Monitoring Plan, Organohalogen Compounds 72: 1766-1769

[21] Rainer Malisch, Karin Kypke, Alexander Kotz, Kerstin Wahl, Nicole Bitomsky, Gerald Moy, Seongsoo Park, Angelika Tritscher, Seoung Yong Lee, Katarina Magulova and Heidelore Fiedler (2011) Levels of HCH, endosulfan, chlordane, nonachlor, S-421, musk xylene and musk ketone in human milk of WHO/UNEP-coordinated exposure study for determination of POPs (2008-2010) with regard to the Global Monitoring Plan, Organohalogen Compounds 73:1023-1025

[22] Hoogenboom LAP, Talidda A, Reeuwijk NM, Traag WA, Kotz A, Malisch R, Moy G, Tritscher A, Lee SL, Magulova K, Fiedler H (2011) Are Elevated Dioxin Levels in Milk of Women from Ivory Coast and Congo due to the use of Clay During Pregnancy? Organohalogen Compounds 73:1026-1029

[23] UNEP/POPS/COP.6/INF/33: Results of the global survey on concentrations in human milk of persistent organic pollutants by the United Nations Environment Programme and the World Health Organization