Dioxins and PCBs in food products: Maximum levels and action levels

Legislative background

Polychlorinated dibenzodioxins and –furans (PCDD/Fs, commonly known as dioxins) and polychlorinated biphenyls (PCBs) are a group of toxic and persistent chemicals whose negative effects on human health and on the environment raised public, scientific and regulatory concern. Over the past decades the European Commission has proposed wide-ranging legislation aimed at directly or indirectly reducing the release of these compounds into the environment, with the objective of reducing human exposure and protecting human health and the environment.

Strategy of the European Union to reduce 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 incidence all along the food chain, i.e. from feed materials through food-producing animals to humans. Taking measures with regard to feed is therefore a decisive step to reduce human intake. These legislative measures concerning feeding stuffs and foodstuffs consist mainly of two pillars [1]:

- Maximum values as a strict but feasible level in food and feed:

If these are exceeded, products intended for animal feed should not enter the European Union from third countries, should not be put into circulation and/or should not be used in the EU.

- Action levels acting as a tool for early warning of higher than desirable levels of dioxin in food or feed:

If these are exceeded, work must be carried out to identify and eliminate the source of contamination.

Legally binding documents (European Union only)

Within the European Union *maximum values* for food products are laid down in Commission Regulation (EC) No 1881/2006 [2], as regards dioxins / PCBs last amended by Commission Regulation (EU) 2022/2002 [3]. An overview about these actual maximum values is given in table 1.

Within the European Union *action levels* for food products are laid down in Commission Recommendation 2013/711/EU [4], last amended by Commission Recommendation 2014/663/EU [5]. An overview about these actual action levels is given in table 2.

Specific requirements concerning the *methods of sampling and analysis* for the official control of food are laid down in Commission Regulation (EU) No 2017/644 [6]. This document distinguishes between screening and confirmatory methods for determination of dioxins and PCBs. The analytical methods used by Eurofins GfA Lab Service GmbH for determination of dioxins and PCBs are confirmatory methods following strictly the requirements of the corresponding EU-legislation. The analytical methods are established on basis of GC-MS/MS, if required also on the HRGC-HRMS measurement technique additionally approved for monitoring purposes. An overview about the different fields of application as foreseen in Commission Regulation (EU) No 2017/644 [6] in its current version is given in table 3.

Performance criteria for the sampling of foodstuffs in the context of the food business operators own control are also laid down in Commission Regulation (EU) No 2017/644 [6].

Maximum values for food products

Table 1: Maximum values for food products (status as of 1st January 2023)

Food	Dioxins (sum of PCDD/Fs): Maximum content in WHO-PCDD/F-TEQ [1]	Sum of dioxins and dioxin-like PCBs (sum of PCDD/Fs and DL-PCBs): Maximum content in WHO-PCDD/F-PCB-TEQ [1]	Non-dioxin-like PCBs: Maximum content [2]
Meat and meat products (excluding edible offal) of the following animals			
- bovine, ovine and caprine animals	≥ 2% fat: 2,5 pg/g fat < 2% fat: 0,05 pg/g wet weight	≥ 2% fat: 4,0 pg/g fat < 2% fat: 0,08 pg/g wet weight	≥ 2% fat: 40 ng/g fat < 2% fat: 0,8 ng/g wet weight
- poultry	≥ 2% fat: 1,75 pg/g fat < 2% fat: 0,035 pg/g wet weight	≥ 2% fat: 3,0 pg/g fat < 2% fat: 0,06 pg/g wet weight	≥ 2% fat: 40 ng/g fat < 2% fat: 0,8 ng/g wet weight
- pigs	≥ 2% fat: 1,0 pg/g fat < 2% fat: 0,02 pg/g wet weight	≥ 2% fat: 1,25 pg/g fat < 2% fat: 0,025 pg/g wet weight	≥ 2% fat: 40 ng/g fat < 2% fat: 0,8 ng/g wet weight
- horse	≥ 2% fat: 5,0 pg/g fat < 2% fat: 0,10 pg/g wet weight	≥ 2% fat: 10,0 pg/g fat < 2% fat: 0,20 pg/g wet weight	---
- rabbit	≥ 2% fat: 1,0 pg/g fat < 2% fat: 0,02 pg/g wet weight	≥ 2% fat: 1,5 pg/g fat < 2% fat: 0,03 pg/g wet weight	
- wild boar (*Sus scrofa*)	≥ 2% fat: 5,0 pg/g fat < 2% fat: 0,10 pg/g wet weight	≥ 2% fat: 10,0 pg/g fat < 2% fat: 0,20 pg/g wet weight	---
- wild game birds	≥ 2% fat: 2,0 pg/g fat < 2% fat: 0,04 pg/g wet weight	≥ 2% fat: 4,0 pg/g fat < 2% fat: 0,08 pg/g wet weight	---
- venison	≥ 2% fat: 3,0 pg/g fat < 2% fat: 0,04 pg/g wet weight	≥ 2% fat: 4,0 pg/g fat < 2% fat: 0,08 pg/g wet weight	---
Liver of bovine and caprine animals, poultry, pigs and horse and derived products thereof	0,30 pg/g wet weight	0,50 pg/g wet weight	3,0 ng/g wet weight
Liver of ovine animals and derived products thereof	1,25 pg/g wet weight	2,00 pg/g wet weight	3,0 ng/g wet weight
Liver of wild game birds	2,5 pg/g wet weight	5,0 pg/g wet weight	---
Muscle meat of fish and fishery products and products thereof [3], with the exemption of: **- wild caught eel** **- wild caught spiny dogfish (*Squalus acanthias*)** **- wild caught fresh water fish, with the exception of diadromous fish species caught in fresh water** **- fish liver and derived products** **- marine oils** The maximum level for crustaceans applies to muscle meat from appendages and abdomen.	3,5 pg/g wet weight	6,5 pg/g wet weight	75 ng/g wet weight
Muscle meat of wild caught fresh water fish, with the exception of diadromous fish species caught in fresh water, and products thereof [3]	3,5 pg/g wet weight	6,5 pg/g wet weight	125 ng/g wet weight
Muscle meat of wild caught spiny dogfish (*Squalus acanthias*) and products thereof	3,5 pg/g wet weight	6,5 pg/g wet weight	200 ng/g wet weight
Muscle meat of wild caught eel (*Anguilla anguilla*) and products thereof	3,5 pg/g wet weight	10,0 pg/g wet weight	300 ng/g wet weight

Food	Dioxins (sum of PCDD/Fs): Maximum content in WHO-PCDD/F-TEQ [1]	Sum of dioxins and dioxin-like PCBs (sum of PCDD/Fs and DL-PCBs): Maximum content in WHO-PCDD/F-PCB-TEQ [1]	Non-dioxin-like PCBs: Maximum content [2]
Fish liver and derived products thereof with the exception of marine oils (fish body oil, fish liver oil and oils of other marine organisms intended for human consumption)	---	20,0 pg/g wet weight	200 ng/g wet weight
Marine oils (fish body oil, fish liver oil and oils of other marine organisms intended for human consumption)	1,75 pg/g fat	6,0 pg/g fat	200 ng/g fat
Raw milk and dairy products, including butter fat	≥ 2% fat: 2,0 pg/g fat < 2% fat: 0,04 pg/g wet weight	≥ 2% fat: 4,0 pg/g fat < 2% fat: 0,08 pg/g wet weight	≥ 2% fat: 40 ng/g fat < 2% fat: 0,8 ng/g wet weight
Poultry eggs and egg products except goose eggs	≥ 2% fat: 2,5 pg/g fat < 2% fat: 0,05 pg/g wet weight	≥ 2% fat: 5,0 pg/g fat < 2% fat: 0,1 pg/g wet weight	≥ 2% fat: 40 ng/g fat < 2% fat: 0,8 ng/g wet weight
Fat of the following animals:			
- bovine animals and sheep	2,5 pg/g fat	4,0 pg/g fat	40 ng/g fat
- poultry	1,75 pg/g fat	3,0 pg/g fat	40 ng/g fat
- pigs	1,0 pg/g fat	1,25 pg/g fat	40 ng/g fat
Mixed animal fats	1,5 pg/g fat	2,50 pg/g fat	40 ng/g fat
Vegetable oils and fats	0,75 pg/g fat	1,25 pg/g fat	40 ng/g fat
Foods for infants and young children [4]	0,1 pg/g wet weight	0,2 pg/g wet weight	1,0 ng/g wet weight

[1] expressed in World Health Organisation (WHO) toxic equivalents, using the WHO-TEFs (toxic equivalency factors, 2005) as upper-bound concentrations; upper-bound concentrations are calculated on the assumption that all values of the different congeners below the limit of quantification are equal to the limit of quantification.

[2] expressed as sum of PCB 28, PCB 52, PCB 101, PCB 138, PCB 153 and PCB 180 (ICES – 6) as upper-bound concentrations; upper-bound concentrations are calculated on the assumption that all values of the different congeners below the limit of quantification are equal to the limit of quantification.

[3] Where fish are intended to be eaten whole, the maximum level shall apply to the whole fish.

[4] The maximum level refers to the products ready to use (marketed as such or after reconstitution as instructed by the manufacturer)

Action levels for food products

Table 2: Action levels for food products (status as of 1st January 2023)

Food	Dioxins (sum of PCDD/Fs): Action level in WHO-PCDD/F-TEQ [1]	Sum of dioxin-like PCBs (sum of DL-PCBs): Action level in WHO-PCDD/F-PCB-TEQ [1]
Meat and meat products (excluding edible offal) of the following animals		
- bovine animals and sheep	1,75 pg/g fat	1,75 pg/g fat
- poultry	1,25 pg/g fat	0,75 pg/g fat
- pigs	0,75 pg/g fat	0,50 pg/g fat
Mixed fats	1,00 pg/g fat	0,75 pg/g fat

Muscle meat of farmed fish and farmed fishery products	1,50 pg/g wet weight	2,50 pg/g wet weight
Raw milk and dairy products, including butter fat	1,75 pg/g fat	2,00 pg/g fat
Hen eggs and egg products	1,75 pg/g fat	1,75 pg/g fat
Clays as food supplement	0,50 pg/g wet weight	0,50 pg/g wet weight
Cereals and oilseeds	0,50 pg/g wet weight	0,35 pg/g wet weight
Fruits, vegetables (including fresh herbs) [2]	0,30 pg/g wet weight	0,10 pg/g wet weight

[1] *expressed in World Health Organisation (WHO) toxic equivalents, using the WHO-TEFs (toxic equivalency factors, 2005) as upper-bound concentrations; upper-bound concentrations are calculated on the assumption that all values of the different congeners below the limit of quantification are equal to the limit of quantification.*

[2] *For dried fruits and dried vegetables (including dried herbs), a concentration factor as the consequence of drying shall be taken into account and shall be provided and justified by the food business operator. For dried herbs, a concentration factor as the consequence of drying of 7 has to be taken into account.*

Field of application of GC-HRMS and GC-MS/MS

Table 3: Field of application of GC-HRMS and GC-MS/MS versus GC-MS-based and bioanalytical methods (status as of 1st June 2019)

Field of application	Gas chromatography / high resolution mass spectrometry (GC-HRMS)	Gas chromatography / tandem mass spectrometry (GC-MS/MS)	Bioanalytical methods ("bio-assays") and GC-MSD
Selection of those samples with levels of PCDD/Fs and dioxin-like PCBs that exceed the maximum levels or the action levels	Approved as confirmatory method	Approved as confirmatory method	Approved as screening method only
Confirmation of compliance of a feed product with the EU maximum level resp. action level	Approved	Approved	Not approved
Confirmation of results obtained by screening methods	Approved	Approved	Not approved
Identification of congener patterns in order to identify the source of a possible contamination	Possible	Possible	Not possible or partly possible
Determination of low background levels in feed monitoring	Approved	Not approved	Not approved
Following of time trends	Approved	Not approved	Not approved
Exposure assessment	Approved	Not approved	Not approved
Building of a database for possible re-evaluation of action levels and maximum levels	Approved	Not approved	Not approved

References

- [1], Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee Community - Strategy for Dioxins, Furans and Polychlorinated Biphenyls (2001/C 322/02) (COM(2001) 593 final) (OJ C 322, 17.11.2001, p. 2–18)
- [2], Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs (OJ L 364, 20.12.2006, p. 5–24)
- [3], Commission Regulation (EU) 2022/2002 of 21 October 2022 amending Regulation (EC) No 1881/2006 as regards maximum levels of dioxins and dioxin-like PCBs in certain foodstuffs (OJ L 274, 24.10.2022, p. 64–66)
- [4], Commission Recommendation 2013/711/EU of 3 December 2013 (OJ L 323, 4.12.2013, p. 37–39)
- [5], Commission Recommendation 2014/663/EU of 11 September 2014 (OJ L 272, 13.9.2014, p. 17–18)
- [6], Commission Regulation (EU) No 2017/644 of 5 April 2017 laying down methods of sampling and analysis for the control of levels of dioxins, dioxin-like PCBs and non-dioxin-like PCBs in certain foodstuffs (OJ L 92, 6.4.2017, p. 9–34)

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