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Normative and pre-normative aspects for the management of actual and perspective POPs in meat and meat products

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Abstract

With the acronym POPs we intend a group of persistent organic pollutants framed within the Stockholm Convention [Stockholm Convention on Persistent Organic Convention (POPs) (2004). Available from http://www.pops.int/]. POPs are a subgroup of the wide family of the aforesaid chemicals present in the environment, that are primarily of industrial origin. According to their physical–chemical properties, bioaccumulative behaviour in lipid tissues, and possible toxicological effects, they represent a relevant and growing concern for human beings. Foodstuffs of animal origin represent the main source of exposure. Monitoring data from national residue plans report only few non-compliances with respect to regulatory limits. However, the estimated intake, as in the case of polychloro-*p*-dibenzodioxins (PCDD), polychlorodibenzofurans (PCDF) and dioxin-like polychlorobyphenils (DL-PCBs) may result close to the correspondent safety guidance value (i.e., the Tolerable Daily Intake), thus indicating the need to reduce the overall exposure. In animal productions, the sources of contamination may be the commercial feedingstuffs as well as the contact with contaminated soil and bedding materials and the overall quality of the environment where animal productions are carried out. In this light, a number of safety challenges are envisaged to produce meat, such as: (a) characterization of the environment, (b) identification of the animal-based risk factors, (c) model-based approaches, able to predict bioaccumulation, and (d) teaching and training of stockmen.

Keywords: Persistent organic pollutants; Meat production; Environment; Food quality control

1. Introduction

Generally, foods of animal origin play an important role in determining the exposure of human beings to contaminants both of biological and chemical origin (Lievaart et al., 2005). In last years, an open debate has been raised about the bioaccumulation of persistent organic pollutants in fish and the derived alimentary exposure (EFSA, 2005a; Hites et al., 2004). In this paper, the environment characteristics, the farming management, and the feeding practices are considered; such factors could influence the exposure to the aforesaid compounds of farmed animals intended for meat production and, if properly managed, could lead to the progressive reduction of residues in edible tissues.

2. The Stockholm Convention

Due to their intrinsic features, persistent organic pollutants can be considered of growing interest for both safety and market aspects. They possess toxic properties, are persistent, bio-accumulate, and are transported—through air, water, and migratory species—across international boundaries: they are deposited far from their place of release, where they accumulate in terrestrial and aquatic ecosystems. Several chemicals are at present framed within the UNEP Convention on POPs, approved in Stockholm in May 2001 by 120 countries as a finalization of a years-long work. The Convention, whose development may be traced back to a 1995 UNEP Council

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and has the goal to reduce and possibly eliminate the environmental presence of POPs, was implemented in 2004 after endorsement by the first 50 countries (Stockholm Convention on POPs, 2004).

Two Criteria Expert Groups (CEG) and five Intergovernmental Negotiating Committees (INC) were in charge for the definition of criteria for selection/inclusion of additional future POPs within the Convention framework, through an updating of its Annexes A (''elimination''), B (''restricted use''), or C (''unintentional production''). After selection of the first 12 prioritary POPs (Table 1), a second group of chemicals is under consideration for inclusion in the Stockholm Convention due to their risk profiles (candidate POPs), whereas a third group is formed by those chemicals proposed for risk evaluation (proposed POPs) (Table 1).

To be ranked among POPs, a chemical (or group of kin chemicals) should comply with the following scientific conditions:

- *persistence* (as half-life): >2 days in air; >2 months in water; >6 months in soil or sediment; or any evidence of persistence adequate for consideration within the Convention;
- *bio-accumulation*: in aquatic species, Bio-Concentration Factor (BCF) or Bio-Accumulation Factor (BAF) >5000 (if data not available, $\log(K_{OW})$ >5); or any evidence of bioaccumulation, also in non-aquatic species, adequate for consideration within the Convention;
- *long-range environmental transport*: monitoring or modelled data proving occurrence of, or potential for Long-Range Transport (LRT) via air, water, or migratory species;
- *adverse effects*: evidence of, or potential for adverse effects to humans.

It is worth noting that the chemicals in Annex A are targeted for elimination; exceptions are DDT (restricted use) and PCDDs and PCDFs (unintentional production). In several cases, production and/or use are subject to specific exemptions, likely reflecting local requirements. For most of them (pesticides), regulatory limits have been already set on meat commodities at European level and in non-European countries, with possible different maximum levels of acceptance according to the animal species (Table 2).

3. Cumulative risk assessment of PCDDs, PCDFs, and PCBs

A paradigmatic example how to assess and manage the risk associated with POPs in the food chain is offered by PCDDs and PCDFs (altogether also known as ''dioxins'') and dioxin-like PCBs (DL-PCBs), the highly toxic fraction of PCBs. The PCDD and PCDF families include a total of 210 congeners; however, only seven and 10 congeners, respectively, are toxicologically relevant due to chlorosubstitution at positions 2, 3, 7, and 8. The important dioxin-like toxic activity is present in only 12 DL-PCBs, subdivided into congeners exhibiting no *ortho* chlorosubstitution (the four ''non-*ortho*'' or co-planar DL-PCBs) and congeners with mono-*ortho* chlorosubstitution (the eight ''mono-*ortho*'' DL-PCBs) (Table 3).

Because these compounds have in common the mode of action and toxicological endpoints, their contemporary presence in the same food item is thought to potentially exert a cumulative effect that cannot be evaluated only on the basis of chemical analytical data. A consensus system of Toxicity Equivalency Factors (TEFs) (Table 3) was set up by WHO (WHO-TEFs) on the basis of toxicological data from *in vivo* and *in vitro* experiments (Van den Berg et al., 1998). The most toxic compound 2,3,7,8-T_4CDD has a unit TEF by definition. As shown in the scheme accompanying the table, the analytical value of each congener is converted to the corresponding TEQs multiplying by the pertinent TEF. The final sum of all Toxicity Equivalency Quantities (TEQs), expressed as pgWHO-TE/g fat, provides a toxicological evaluation of the contamination present in food commodities due to PCDDs, PCDFs, and DL-PCBs. Partial TEQ sums can

Table 1
POPs already included in the Stockholm Convention and persistent organic pollutants that may qualify for inclusion

Priority POPs included in the Stockholm Convention[a]		
Aldrin	Endrin	Polychlorobiphenyls (PCBs)
Chlordane	Heptachlor	Polychlorodibenzodioxins (PCDDs)
DDT (*p*,*p*′-DDT)	Hexachlorobenzene (HCB)	Polychlorodibenzofurans (PCDFs)
Dieldrin	Mirex	Toxaphene
Persistent organic pollutants that are being considered for inclusion in the Stockholm Convention[b]		
Chlordecone	Lindane (*gamma*-HCH)	Perfluorooctane sulfonate (PFOS)
Hexabromobiphenyl	Pentabromodiphenyl ether	
Persistent organic pollutants newly proposed for inclusion in the Stockholm Convention[b]		
alpha-HCH	Octabromodiphenyl ether	Short-chained chlorinated paraffins
beta-HCH	Pentachlorobenzene	

[a] All compounds are targeted for ''elimination'', with the exception of DDT (''restricted use'') and PCDDs and PCDFs (''unintentional production''). In most cases, production and/or use are subject to specific exemptions, likely reflecting local requirements.
[b] Updating of Annexes A, B, or C of the Convention by the POPs Review Committee. Second meeting, November 6–10, 2006.