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European developments following incidents with dioxins and PCBs in the food and feed chain

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ABSTRACT

Incidents with dioxins and PCBs have resulted in a strategy within the EU to reduce the exposure of the population to these compounds. Maximum levels were set for food and feed products and criteria were developed for the analytical methods (both confirmatory and screening) used for official control measurements. Ideally, any analysis performed with the aim of comparing the result with the legal limits should be performed according to these criteria. It should also apply to monitoring, performed to estimate human exposure and trend analysis rather than compliance with limits, since risk assessments and EU-policies rely heavily on these data.

In recent years, analytical capacity has largely increased to complement the additional testing. In line with the responsibility of producers for the safety of their products, self-control has strongly increased and has played an important role in the discovery of several of the incidents. However, the increased monitoring seems not to have resulted in a clear further decrease in the levels reported for food and feed in the last decade. This may in part be due to a lack of follow up when elevated levels (above action levels) are found, which would lead to a reduction of output from remaining sources. It may also be related to the sensitivity of applied methods and the data collected in databases.

This paper reviews the incidents and developments that have taken place within the EU over the last 15 years in the area of dioxins and PCBs, including the role of applying screening and confirmatory methods for achieving the desired further reduction in the levels.

Contents

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1. Introduction

Dioxins and PCBs are a major concern for food safety. Dioxins were first reported as important contaminants of the food chain in the 1950s when thousands of chickens in the US became diseased and died (Firestone, 1973; Higgenbotham et al., 1968; Sanger, Scott, Hamdy, Gale, & Pounden, 1958; Schmittle, Edwards, & Morris, 1958). The problem was caused by the production of feed with fat scraped from cow hides treated with chlorophenols. It took ten years to identify dioxins as the cause of the effects in the hens. Around that time another incident occurred where chickens were exposed to water contaminated by a pesticide plant producing chlorophenols. These pesticides were also responsible for one of the major environmental incidents with dioxins, occurring in Seveso in 1974 (Mocarelli et al., 1986) and were also the source of dioxins in Agent Orange used as a defoliant during the Vietnam war (Westing, 1989).

The hens in the earlier incidents showed an effect termed chicken oedema disease. The description of this syndrome guided a Belgian veterinarian in March 1999 to investigate whether dioxins could be the cause of a problem with feed at poultry production farms. In January of that year, chickens became diseased and eggs hatched very poorly. The feed was replaced, which reduced the problem, but the veterinarian was eager to find the cause in order to prevent similar problems in the future. After excluding various other causes, he decided to pay the relatively high costs for a dioxin analysis. Levels of dioxins in feed and hens turned out to be extremely high, being 781 ng TEQ $kg^{-1}$and 958 pg TEQ g^{-1} fat (Traag, Kan, van der Weg, Onstenk, & Hoogenboom, 2006). The predominance of the chlorinated furans (PCDFs) indicated the presence of PCBs, which was confirmed by additional analyses, showing a level of 30 mg kg^{-1} feed for the 7 indicator PCBs. Based on this level, the relative contribution of indicator PCBs to the total, and the amount of feed produced, it was estimated that at least 160 kg of PCB oil had somehow been mixed into plant fat that was used by several companies to produce feed for chickens and pigs (Traag et al., 2006). During the 3 months it took to establish the cause of the problem, the contamination spread and it was difficult, if not impossible, to trace the contaminated products. Fat from exposed animals had also been rendered from the slaughterhouse offal and reused for the production of new animal feed, thus leading to a second contamination cycle (Bernard et al., 1999, 2002; De Bont, Elskens, Baeyens, Hens, & Van Larebeke, 2004; Van Larebeke et al., 2001).

In 1999, few laboratories were able to analyse dioxins in food and feed. Fortunately, as PCBs were the main source, so-called indicator PCBs (sum of seven specific PCB congeners), present at much higher levels (50,000 times the dioxin TEQ-level), could be used for distinguishing contaminated from uncontaminated products. Special PCB-limits were derived in Belgium and a large number of laboratories were appointed to perform the tests. In The Netherlands, the CALUX-bioassay had shown its merits as a screening method in the 1998 citrus pulp incident (see below) and was used to establish the absence of elevated levels of dioxins and dl-PCBs. This turned out to be very useful since five months after the actual incident, most food products were not contaminated. A prerequisite was of course that the application of the test would not result in false-negative results.

The incident in Belgium triggered major changes to the EU policy on food safety, and dioxins and PCBs in particular. This paper reviews the problems around these compounds in the food chain and the sequence of events on the risk assessment and management, leading to the establishment of EU-legislation. It also addresses the control of feed and food for the presence of these compounds and the application of different analytical tools. In addition, trends in the levels and some potential problems in trend analysis are discussed.

2. Properties and effects of dioxins and PCBs

2.1. Structures and sources

Dioxins is a term used for a selected group of 210 chlorinated compounds consisting of two subgroups, the polychlorinated dibenzo-p-dioxins (PCDDs, 75 congeners) and the polychlorinated dibenzofurans (PCDFs, 135 congeners) (Fig. 1). Especially the 17 congeners with chlorine atoms at the 2, 3, 7 and 8 positions appear to be of importance since these are relatively resistant to metabolic degradation. As a result they accumulate in the body, especially in subcutaneous and visceral fat and liver, and to some extent are mobilised through the circulatory system. The most toxic congener, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) has an estimated half-life in humans of about 7 years (WHO, 2000).

In addition to PCDD/Fs, various other groups of compounds have similar properties in terms of persistence and effects. This includes 12 so-called dioxin-like PCBs (dl-PCBs) with at least 4 chlorine atoms and in such positions that the two phenyl rings can adopt a planar position. This is only possible when the ortho positions are either unsubstituted (non-ortho) or just by one chlorine (mono-ortho) (Fig. 1). Other PCBs are termed non-dioxin-like (ndl-)PCBs, some of them also showing rather persistent properties. Although in theory there are 209 PCBs, only a limited number are determined when analysing these ndl-PCBs. Originally these were termed indicator PCBs and included PCBs 28, 52, 101, 118, 138, 153, 180, but PCB 118, being also a dl-PCB, was excluded.

PCDD/Fs are present as by-products in a number of chlorinated chemicals like chlorophenols including the wood preserving pentachlorophenol (PCP), and PCBs. Furthermore they can be formed during incineration of waste containing materials like