

PCB, PCDD and PCDF residues in fin and non-fin fish products from the Canadian retail market 2002

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Abstract

Fish products ($n = 129$) available on the Canadian retail market were collected and analyzed for levels of PCBs, PCDDs and PCDFs during the spring of 2002. The collection included samples from eight fish groups (Arctic char, crab, mussels, oysters, salmon, shrimp, tilapia, trout) from the wild and those raised on fish farms, as available. Sample collection included both domestic and imported fish products, however, no significant difference in residue levels was observed between these groups of fish products. Salmon samples were found to contain the highest concentration of $\sum$ PCBs (geometric mean 12.9 ng/g wet weight), while crab samples had greatest $\sum$ PCDD/F levels (geometric mean 0.002 ng/g wet weight). The geometric mean of the total toxic equivalents (WHO-TEQ) ranged from 0.06 pg WHO-TEQ/g whole weight in farmed shrimp to 1.1 pg WHO-TEQ/g whole weight in farmed salmon samples. PCB 153, 138, 118 and 101 were the dominant congeners observed in fish product samples studied, while 1,2,3,7,8-pentachlorodibenzodioxin and 2,3,7,8-tetrachlorodibenzofuran contributed the most to total PCDD and PCDF loadings. Lipid content was positively correlated to $\sum$ PCB levels; however, no relationship between lipid content and $\sum$ PCDD/F concentrations was established. $\sum$ PCB levels were below the Canadian guideline value for PCBs in fish and fish products (2000 ng/g). Similarly, 2,3,7,8-TCDD levels in all fish products were below the Canadian guideline value (0.020 ng/g).

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1. Introduction

Polychlorinated biphenyls (PCBs), polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs) all belong to the broader class of compounds known as organochlorines. This class is considered to be resistant to degradation and persists in the environment (Storelli et al., 2003; Oh et al., 2003). PCBs were produced and used as lubricants, stabilizers in paints, polymers and adhesives (Kimbrough and Jensen, 1989), while PCDDs and PCDFs are produced as by-products of industrial processes, such as incineration of wastes, production of pesticides and bleaching of pulp (Yang et al., 2002). These compounds are ubiquitous in the environment and are known to bioaccumulate in the lipids of exposed organisms (Bordajandi et al., 2004; Sandanger et al., 2003; Mondon et al., 2001). Biomagnification of these persistent organic pollutants (POPs) through the food chain has been well documented in the literature (Serrano et al., 2003a; Easton et al., 2002).

Although studies have shown that these compounds are widely distributed throughout the environment, ingestion via food consumption is the major source of human exposure (Bordajandi et al., 2004; Storelli et al., 2003; van Leewen et al., 2000; Newsome et al., 1998). PCB, dioxin and furan concentrations are elevated in foods that have higher lipid content and are generally associated with foods of animal origin (Holmes et al., 2003). Studies to determine the levels of POPs, including PCBs and PCDD/Fs in foods have been performed regularly in Canada as part of the Total Diet Study (Newsome et al., 1998; Ryan et al., 1992, 1991), which has been ongoing since 1969 (Newsome et al., 2000; Conacher et al., 1989).

Uptake of dioxins, furans and PCBs has been of concern due to their potential adverse health impacts to humans. This group of compounds is linked to immunotoxicity and carcinogenicity (Fernandez et al., 2004). Recently concerns have been raised about these compounds impacting normal endocrine function and reproduction in fish and wildlife (Okumura et al., 2004; Sapozhnikova et al., 2004). Additionally, transfer of PCBs and PCDD/Fs to infants either prenatally or via human milk is known to occur and may result in growth delay, developmental defects and neurocognitive deficits (Wang et al., 2004).

Consumption of fish as part of the diet is considered healthy due to their high protein, unsaturated essential fatty acid, mineral and vitamin content (Institute of Medicine, 2003; Sidhu, 2003) and advocated by governments across North America (Health Canada, 2004). In the past, fish available for consumption were primarily taken from the wild and residue levels in the fish corresponded to regional contaminant loads (Ross et al., 2004, 2000; Ryan et al., 1997) that could result in fish consumption advisories (Kearney and Cole, 2003). Fishery stocks, however, have been declining in recent years, which has allowed for the rapid expansion of the aquaculture industry throughout the world (Serrano et al., 2003b; Naylor et al., 2000). Commercial feeds, such as those frequently used in aquaculture operations, containing fish oils with background levels of PCBs, dioxins and furans are thought to contribute to the contaminant loads in fish fed these products (Jacobs et al., 2002a). Fish consuming the feed products are subject to accumulation of these POPs. Comparative studies to determine the contaminant levels in farmed fish relative to wild fish have been performed recently (Hites et al., 2004; Lung et al., 2003; Easton et al., 2002). Higher PCB and dioxin loads have been observed in some fish raised through aquaculture activity than in the wild (Hites et al., 2004; Easton et al., 2002). Health Canada has, however, concluded that Canadians are not exposed to PCB levels in fish at levels sufficiently high to pose a health risk (Health Canada, 2004). The present study was established to determine PCB, PCDD and PCDF loadings in the edible portions of fish and non-fin fish commercially available in Canada.

2. Materials and methods

2.1. Sample collection and preparation

Market samples of fresh and salt water fish and shellfish ($n=129$) were purchased from retailers in three major urban centres (Halifax, Nova Scotia; Ottawa, Ontario; and Vancouver, British Columbia) across Canada during the winter and spring of 2002. Both farmed and wild fish were purchased, but the majority of samples represented products from aquaculture facilities because limited wild fish/shellfish were available on the market owing to the timing of

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