

Global Assessment of Polybrominated Diphenyl Ethers in Farmed and Wild Salmon

Environmental Science Technology
38 (19), 4945 -4949, August 10, 2004

Ronald A. Hites, Jeffery A. Foran, Steven J. Schwager, Barbara A. Knuth, M. Coreen Hamilton, and David O. Carpenter

FROM ABSTRACT:

We have shown recently that levels of persistent, bioaccumulative contaminants (polychlorinated biphenyls, dioxins, and several chlorinated pesticides) are significantly higher in farmed than in wild salmon and that European farm-raised salmon have significantly greater toxic contaminant loads than those raised in North and South America.

In this paper, we extend these results to polybrominated diphenyl ethers (PBDEs) and show that farm-raised salmon have higher levels of these compounds than wild salmon.

We also show that farm-raised salmon from Europe have higher PBDE levels than those raised in North America and that both European and North American farm-raised salmon have higher PBDE levels than those farm-raised in Chile.

Among the species of wild salmon, chinook had significantly elevated PBDE levels relative to the other wild species.

These elevated PBDE levels may be related to chinook's feeding behavior and trophic level.

Among all of the wild species we studied, chinook tend to feed higher in the food web throughout their adult life and grow to be larger individuals.

THESE AUTHORS ALSO NOTE:

"Polybrominated diphenyl ethers (PBDEs) serve as flame retardants in a wide variety of commercial and household products. For example, polyurethane foam, which is used widely in upholstered furniture, is flammable unless it is treated with suitable flame retardants such as PBDEs."

"Because many governments now have regulations requiring household products to be flame resistant," polybrominated diphenyl ethers use and global annual sales has increased greatly.

Polybrominated diphenyl ethers are now migrating from the products in which they are used and entering the environment and people.

"PBDEs are now ubiquitous; they can be found in air, water, fish, birds, marine mammals, and people."

"One source of PBDEs in people is their food supply, and an increasingly important food is salmon, which is nutritious and high in beneficial fats."

"Between 1987 and 1999, salmon consumption increased annually at a rate of 14% in the European Union and 23% in the United States."

"Currently, over half the salmon sold globally is farm-raised," as predominantly Atlantic salmon.

Both farmed and wild salmon have been shown to bioaccumulate contaminants.

"In a previous study, we reported that levels of persistent, bioaccumulative contaminants (such as PCBs, dioxins, and several chlorinated pesticides) are significantly higher in farm-raised salmon than in wild Pacific salmon and that salmon raised on European farms have significantly greater toxic contaminant loads than those raised on North and South American farms."

These authors measured PBDEs in about 700 farmed and wild salmon collected from around the world.

Farmed Atlantic salmon (*Salmo salar*) are primarily raised in Norway, Chile, Scotland, British Columbia, Eastern Canada, the Faroe Islands, Ireland, Maine, and the state of Washington.

The wild fish species of Pacific salmon analyzed were chum, coho, Chinook, pink, and sockeye. Samples of each species were purchased from different geographic regions, including Kodiak, AK; Southeast Alaska; British Columbia; and Oregon.

RESULTS AND DISCUSSION:

Total polybrominated diphenyl ethers in the farmed salmon were significantly more concentrated as a group than in the wild salmon.

"PBDE concentrations were significantly higher in farmed salmon from Europe than from North America, in farmed salmon from North America than from Chile, and in farmed salmon from Chile than in wild salmon."

"PBDE concentrations in the salmon purchased from retail outlets in Europe were significantly higher than those in salmon purchased in stores in North America."

Both European and North American store-bought samples had average polybrominated diphenyl ether concentrations much higher than in wild salmon.

"Salmon fillets purchased from supermarkets in Edinburgh and London were generally the most contaminated with PBDEs, and those purchased in Washington, DC, and New Orleans were the least contaminated of the store-bought samples."

"Most of the salmon sold in European stores comes from European farms, which produce the more contaminated salmon, while most of the salmon sold in U.S. stores comes from Chile and Canada."

The chinook samples from British Columbia and Oregon had relatively high PBDE concentration. "Among all of the wild species we studied, chinook tend to feed higher in the food web throughout their adult life stage, feeding mainly on fish, and grow to be larger individuals on average, whereas other species' diets rely more on invertebrates and zooplankton."

The large differences between the farmed and wild salmon polybrominated diphenyl ethers concentrations are most likely a function of their diet. Farmed salmon are fed a concentrated feed high in fish oils and fish meal, bioaccumulating polybrominated diphenyl ethers.

"The absolute PBDE dose is much higher for the farmed relative to the wild salmon."

Polybrominated diphenyl ethers are metabolically active compounds that "disrupt spontaneous behavior, impair learning and memory, and induce other neurotoxic effects in adult mice exposed during neonatal life. These effects occur in both a dose/response and time/response fashion, can worsen with age, and may be inducible during relatively short but critical periods of neonatal development."

"PBDEs are also endocrine disruptors, altering thyroid hormone homeostasis and causing a dose-dependent depletion of T4."

There are concerns that polybrominated diphenyl ethers may be carcinogenic.

"Frequent consumption of farmed salmon and wild Pacific Chinook salmon will increase human dietary exposure to PBDEs much more so than consumption of most other wild Pacific salmon."

"PBDE concentrations now observed in humans may leave little or no margin of safety; thus, prudent public health practice argues for the selective consumption of food, including many wild salmon species that contain comparatively lower concentrations of PBDEs as well as lower concentrations of many chlorinated organic contaminants."

"Salmon with lower PBDE concentrations still contain omega-3 fatty acids, and associated health benefits can be accrued by consumption of these fish with commensurately lower, contaminant-associated health risks."

"This study demonstrates the importance of labeling salmon as farmed and identifying the country of origin."

"This conclusion is consistent with the recommendations of a recent panel of the Institute of Medicine, which called for major efforts to reduce the content of dioxin-like compounds in food given to animals and fish that are used for human consumption."

KEY POINTS FROM DAN MURPHY

- 1) Levels of persistent, bioaccumulative contaminants, such as polychlorinated biphenyls, dioxins, and chlorinated pesticides, are significantly higher in farmed than in wild salmon and that European farm-raised salmon have significantly greater toxic contaminant loads than those raised in North and South America.
- 2) Polybrominated diphenyl ethers are flame retardants that are used in many commercial and household products, such as upholstered furniture.
- 3) Because governments now have regulations requiring household products to be flame resistant, polybrominated diphenyl ethers are now ubiquitous; they can be found in air, water, fish, birds, marine mammals, and people. **[Another example of the "Law of Unintended Consequences": In an effort to reduce fires, governments have legislated-in the use of chemicals that harm our bodies, brains, hormones, and increases cancer risk.]**
- 4) Both farmed and wild salmon have bioaccumulated contaminants like polychlorinated biphenyls, dioxins, and chlorinated pesticides and polybrominated diphenyl ethers.
- 5) Over half the salmon sold globally is farm-raised.
- 6) Atlantic salmon is always farmed-raised.
- 7) Farm-raised salmon from Europe have higher polybrominated diphenyl ethers levels than those raised in North America and that both European and North American farm-raised salmon have higher polybrominated diphenyl ethers levels than those farm-raised in Chile.
- 8) Among species of wild salmon, chinook has the highest polybrominated diphenyl ethers levels.
- 9) Total polybrominated diphenyl ethers in the farmed salmon were significantly more concentrated than in the wild salmon.

- 10) Both European and North American store-bought salmon have average polybrominated diphenyl ethers concentrations much higher than in wild salmon.
- 11) Polybrominated diphenyl ethers disrupt spontaneous behavior, impair learning and memory, and induce other neurotoxic effects. They are especially bad during critical periods of neonatal development.
- 12) Polybrominated diphenyl ethers are also endocrine disruptors, altering thyroid hormone homeostasis and a depletion of T4.
- 13) Polybrominated diphenyl ethers may be carcinogenic.
- 14) The polybrominated diphenyl ethers concentrations now observed in humans may leave little or no margin of safety; therefore, we should not eat farmed salmon and should not overeat chinook salmon.