INTERNATIONAL CONCERN OVER PERSISTENT ORGANIC POLLUTANTS (POPS) IN FOODS: RISK ASSESSMENT AND PUBLIC POLICY

Dennis Paustenbach[1] and Kevin Connor[2]

[1]Exponent, 149 Commonwealth Drive, Menlo Park, CA 94205
[2]Exponent, 8201 Corporate Drive, Ste 680, Landover, MD 20785

Introduction

Over the past ten years, it has become increasingly clear that polychlorinated dibenzodioxins and furans (PCDD/Fs), polychlorinated biphenyls (PCBs), DDT, chlordane and other so-called *persistent organic pollutants (POPs) are present in human blood and adipose tissue as a result of* our diet[1]. A number of studies have estimated that over 90 percent of the average daily exposure to the dioxins and furans is due to ingestion of foods[2, 3]. For these compounds and many other POPs, foods such as dairy, fish, and meat products are known to be the major sources of exposure. The improved capacity for detecting POPs at very low levels in foods and tissues, as well as the publicity surrounding the presence of POPs in the human food chain continues to elicit significant public concern. By the end of 2000, the UNEP hopes to enact a global agreement to "prohibit, restrict, or reduce the production, use, or release of certain POPs"[4].

The purpose of this paper is to present an overview of the various issues which face the regulatory agencies of nations around the world. It attempts to focus on both the scientific and policy issues associated with POPs in the environment.

What are POPs?

The term POPs has emerged to describe a group of global environmental contaminants, including DDT, PCBs, PCDD/Fs and related chemicals. POPs persist in the environment, bioaccumulate, are toxic, and pose an environmental risk to humans and ecosystems at sufficient doses[4]. There are national and international criteria for POPs, but no consensus has been achieved among concerned parties. The listing criteria vary and as a result, there is no accepted list of POPs. For example, the United Nations Environment Programme (UNEP) uses the following parameters to identify a POP: Persistence (Half-life in air greater than 2 days, half-life in water, soil, and sediment 2-6 months); bioaccumulation (BCF/BAF = 1000-5000 in fish or if no value available, use Kow > 10,000 or log Kow > 4); toxicity; volatility (Vapor pressure = <1000 Pa); long-range transport; and bioavailability[5]. The USEPA PBT (persistent bioaccumulative and toxic) Program stems from a 1997 agreement with Canada to reduce emissions of certain Great Lakes contaminants. Under this agreement, PBTs are chemicals that partition into water, sediment or soil, and bioaccumulate in aquatic or terrestrial species; this includes metals in addition to POPs. Suspected PBTs are confirmed with toxicity tests. The Great Lakes Basin Binational Toxics Strategy (BNT) has a slightly different list.

The "original" POPs, known as the dirty dozen, identified by the UNEP Governing Council included aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, heptachlor, hexachlorobenzene, mirex, PCBs, and toxaphene. USEPA's PBT strategy has a slightly different list of priority chemicals which includes aldrin/ dieldrin, benzo(a)pyrene, chlordane, DDT, dioxins and furans, hexachlorobenzene, alkyl-lead, mercury, mirex, octachlorostyrene, PCBs, and toxaphene.

Perhaps the ultimate criterion for a POP is its presence at low levels in rural soils, or in sediments of otherwise pristine waterbodies. In this regard, *biomagnification* may be the defining feature of a POP, giving rise to widespread distribution of POPs, and the presence of POPs in the human diet. The contribution of evaporation and atmospheric recycling to the global distribution of several POPs is fairly well established and deserves further consideration as another defining process.

There is great divergence in the POPs with respect to the sources and patterns of release. The widespread distribution of dioxins is due to emissions to the atmosphere from incineration and combustion sources. In contrast, the widespread distribution of PCBs is due to the re-release from historical deposits (e.g., manufacturing or waste sites) and cycling through rivers, lakes, and the atmosphere.

POPs in Human Populations

Currently, many of the POPs can be detected in the blood or adipose tissue of virtually all persons who reside in developed countries. Concentration of the various POPs in human tissues is related primarily to high lipid solubility, slow metabolism and a regular intake from food. For the dioxins, for example, background concentrations in the adipose of persons in the United States tended to be about 6 ppt for 2,3,7,8-TCDD and 840 ppt for OCDD. Current levels in children have decreased to 2-3 ppt for TCDD. However, the hazard identification and risk management process are complicated because some POPs, like dioxin act via the same or similar modes of action as some naturally occurring chemicals. For example, there are naturally occurring Ah receptor agonists, such as indole-3-carbinol (I3C) and its metabolites. I3C is found in large amounts in a number of vegetables of the *Brassica* genus (cabbage, cauliflower, and brussel sprouts), and acute Ah-receptor responses can easily be measured in individuals following consumption of these items[6].

For a number of years, it has been considered prudent to pursue viable measures to reduce the concentration of POPs in both the general environment and in foods. It is unclear whether current background blood levels in developing countries poses any health risk but since there are no known benefits of low level exposure to these chemicals, it is generally agreed that the global community should attempt to prevent increases in ambient concentrations (as well as those in the general population).

The Possibility of Food Wars

International interest in POPs has grown as a result of a few incidents where foods were sold that contained relatively high concentrations of POPS, in particular the PCBs and the furans. Proposals have been made that every country which is a major exporter of food should be expected to assay some portion of the foods on a routine basis to insure that they have concentrations of certain chemicals well below particular criteria. This process could potentially curtail the distribution of food contaminated with elevated concentrations of POPs, although, under the best of circumstances, it would probably not be possible to prevent short-term distribution of tainted foods. There have been several incidents including a situation in the United States where ball clay containing dioxins was used as an additive to animal feed and a food scare in Belgium where dioxin was detected in certain meats that have increased public awareness over the past 3-4 years.

As the international marketplace becomes more competitive, it is anticipated that advertising and promoting food quality will also become increasingly important. The comparison of food quality between producers might focus on freshness, or nutrition, however, concentrations of POPs present in particular foods is another area where comparisons could be made. This presents a challenge to regulators who want a clear and accurate message to be sent to the public

In recent years, very large sums of money have been spent by many nations in an attempt to reduce the releases of various POPs to the environment. Controls have been placed on airborne and waste water emissions. Tens of Billions of dollars have been spent in the United States on eliminating the loss of chemicals from landfills and historical production facilities. In Europe and elsewhere, programs have been implemented to continually reduce the allowable emissions (aerially and via water) of the dioxins, as well as select other POPs. This progressive reduction in emissions is consistent with international initiatives to adhere to the precautionary principle, although, at times, it is in conflict with those policies to rely on health risk assessment to identify acceptable levels of emissions.

Over time, it can be expected that some countries will expect that if other nations are not willing to invest monies into controlling the production and release of this class of chemicals, then market forces will be used to encourage them to do so. For example, assume that the Republic of Georgia exports large quantities of St. Peters fish to the United States and that those fish have TEQ concentrations of the dioxins which are ten-fold lower than that observed in the same fish from other countries (who may not be dealing with dioxin contaminated sediments). It is entirely possible that they will begin to label their fish in some manner that conveys that their fish are "less contaminated with persistent chemicals" than others in an attempt to gain some competitive advantage. It is likely that this use of market forces could produce significant confusion in the marketplace due to the complexity of the issue. Thus, it would appear much better if regulatory agencies were to simply insure the safety of the various foods through international agreement.

The Role of Risk Assessment in the Process

The first objective of a POPs program is to identify new compounds that have the potential to become global pollutants, based solely on their physico-chemical properties. This is a fairly objective task, although there will likely be continued debate over the selection of the parameters and parameter values to be used as the defining criteria. However, the POPs programs originated largely based on public concern over the environmental or human health consequences of their widespread distribution. Indeed, a POP should have the potential to "endanger parts of the biosphere as well as human populations[5]. Therefore, the next phase of the POPs program will be deciding what to do with the list-- a much less straightforward task.

The necessity for building risk assessment into the POPs framework was recognized during the 1999 meetings of the CEG, when questions started to emerge that can only be answered by risk assessment (e.g., [What are] "levels of potential concern"?). The favored approach to risk assessment in the U.S. has been generally defined by the principles and approaches used in the U.S. EPA's *Risk Assessment Guidance for Superfund (RAGS)*. However, it may be stretching this paradigm to the limits when it is applied to the evaluation of global health risks from very low-level tissue residues of POPs—RAGS was primarily intended as a means of prioritizing hazardous waste sites and is based on exposure limits derived from high-dose rodent studies; that is, it is a screening approach. The only scientifically credible means of risk assessment for POPs may be the use of epidemiology. We are approaching the 30 year period since the peak human exposures to the prototypical POPs occurred, and thus we should soon be able to detect any adverse health effects that may have been caused by these exposures[4].

Another aspect of risk assessment that is gaining widespread support, and is especially important for the risk assessment of POPs is risk-benefit analysis. The importance for risk-benefit analysis has been recognized by the CEG, which has written in provisions for *special considerations* based on social and economic factors, e.g., the need to conserve biodiversity or protect endangered species. However, if the results of risk assessment will be used to promote regulatory actions limiting exposures, or to blocking all production and release of POPs, then it should also weigh the human costs of such actions, e.g., further limits on PCB exposure will restrict fish consumption, a global ban on DDT could cause malaria outbreaks in developing countries, a ban on polybrominated diphenyl ethers could diminish the fire safety of consumer products, etc. An example of poor communication gone awry is the decrease in breast feeding that occurred when it was reported that levels of dioxins are highest in infants. Clearly, a great many factors need to be considered as the various nations, and the food producers and processors, attempt to deal with this issue.

Discussion

The international concern over the presence of POPs in our diet and in the adipose/blood of citizens of various developed nations is one that deserves lively discussion. Over the past ten years, the concentration of many of these chemicals has been decreasing in the United States and in several other nations that monitor POPs. However, it is not yet clear to what degree these chemicals are present in food in other countries and studies of additional populations need to be conducted. This type of research should help to clarify the objectives of an international POPs program. Should the emphasis be on increasing the regulation of the so called "dirty dozen", or on preventing the next "dioxin" from entering the global environment? Nonetheless, at international POPs conventions the current debate is only over whether POPs should be eliminated or limited—this is before it is known how risk assessment will be applied to the listing criteria. A framework for identifying POPs with physical and chemical properties has been established. This framework urgently needs to overlain with a classification scheme based on the toxicological properties and risks to the environment and human health.

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