Executive summary

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Hazardous Chemicals in Plastic Products and Food Chain in Kenya

POPs in plastic consumer products and free-range chicken eggs from Kenya

Introduction

Developing countries, including countries in Africa, suffer from the health and environmental impacts of toxic chemicals and wastes more than developed countries. This is in part the result of loopholes in international legislation and abuses by large corporations and countries that export waste containing dangerous chemicals. Burning waste generates new, even more toxic chemicals, such as chlorinated and brominated dioxins and polyaromatic hydrocarbons.

Another source of human exposure to toxic chemicals is plastic consumer products. Some of chemicals in plastic products are intentionally added to confer certain properties, others end up in the products made from recycled plastics because chemicals in plastics are transferred when plastics are recycled.

Aim of the study

This study aims to determine whether persistent organic pollutants (POPs) find their way into consumer products and human food in Kenya due to waste management practices such as recycling, dumping, or burning. The research aims to contribute to the discussion on setting appropriate international standards and limits for the content of persistent organic pollutants (POPs) in consumer products and waste.

Methodology

Pooled samples of free-range chicken eggs were collected in the vicinity of potential POPs pollution hot spots:

- Nairobi - Dandora, a dumpsite where plastic waste is burned;
- Nairobi – Ngara market, a market which is a major e-waste dismantling site (see also photo);
- Nairobi - Mirema, a “community cooker” that uses plastic waste as fuel;
- Nanyuki, near a dumpsite with open burning and e-waste disposal.

Eggs from a supermarket in Nairobi were used as reference sample. The eggs were analyzed for polychlorinated and polybrominated dioxins (PCDD/Fs, PBDD/Fs), polychlorinated biphenyls (PCBs),

hexachlorobenzene (HCB), pentachlorobenzene (PeCB), hexachlorobutadiene (HCBD), polychlorinated naphthalenes (PCNs), short-chain chlorinated paraffins (SCCPs), 3 isomers of hexachlorocyclohexane (HCH), 6 isomers of dichlorodiphenyltrichloroethane (DDT), 3 isomers of hexabromocyclododecane (HBCD), polybrominated diphenyl ethers (PBDEs), six novel brominated flame retardants (nBFRs), and per- and polyfluoroalkyl substances (PFASs). All were analyzed in certified laboratories in Czechia, Netherlands, or Germany. A daily dietary intake was calculated for PCDD/Fs plus DL-PCBs, PBDD/Fs, and PFoS. The results of the calculations were compared with the tolerable daily intake (TDI) established by different regulatory authorities (EFSA and WHO).

Eighteen black plastic products (products that tend to come from recycled e-waste plastics and plastics from end-of-life vehicles (ELVs)) with elevated levels of bromine and antimony purchased from markets in Kenya were selected for laboratory analysis at the Department of Food Analysis and Nutrition, University of Chemistry and Technology based in Prague, Czechia. Groups of PBDEs, HBCD and nBFRs, and Tetrabromobishpenol A (TBBPA) were analyzed in these products. A toy car was also analyzed for brominated dioxins at the MAS laboratory in Muenster, Germany and for dioxin-activity by DR_{human}CALUX.

Results and comparison with legal threshold

In most cases, the analyzed POPs levels in the eggs from the selected hot spots in Kenya exceeded by many times the levels measured in reference samples purchased from a supermarket in Nairobi.

The levels of dl PCB congeners measured in both samples from the Ngara market were the highest ever measured in free chicken eggs globally (see comparison in graph at Figure 1). The levels of indicator PCB congeners in the two pooled egg samples from the Ngara market exceeded the EU regulatory limit of 40 ng/g fat by more than 30 and 55 times, respectively. The level of indicator PCB congeners in the eggs from the Dandora dumpsite reached half of the EU limit.

The levels of PCDD/Fs in free-range egg samples in this study were two to eight times higher than the EU regulatory limit of 2.5 pg TEQ/g fat. The highest level was in eggs from the Dandora dumpsite, followed by eggs from the Ngara market and Mirema.

The sum of PCDD/Fs + dl PCBs was 100 and 111 times, respectively, above the EU regulatory limit of 5 pg TEQ/g fat in two pooled egg samples from the Ngara market. Based on the level of PCDD/Fs + dl PCBs in the eggs from the Ngara market, the average per capita consumption of eggs in Kenya (36 eggs per year), which is considered to be very low, would exceed the TDI for PCDD/Fs + dl PCBs by 5 to 6 times. In addition, we can also say that a person eating just one egg from the Ngara market would be exposed to a cumulative dose of dioxins and dioxin-like compounds that would span nearly 200 days to more than 250 days, based on the TDI set by EFSA.

The laboratory analysis of 18 samples of consumer products made of recycled black plastic purchased in Kenya revealed that 14 of them exceed the limit for definition of hazardous POPs waste suggested by African region. Across all 18 samples, there were six novel BFRs found at concentrations ranging from 0.2 ppm to 412 ppm. Tetrabromobisphenol A (TBBPA), the most widely used BFR, was found in 16 out of the 18 samples, at concentrations ranging from 0.3 ppm to 980 ppm.

One sample, a toy car, was analyzed for brominated dioxins and was found to contain 6,590 pg TEQ/g, which is much higher than concentrations observed, for example, in waste incineration ashes or pyrolysis residues.

Conclusions

Leakage and emissions of POP additives from waste is a source of contamination of free-range chicken eggs with BFRs and PFASs in the vicinity of dumpsites and/or community cookers using plastic waste as fuel. Burning plastic waste containing chlorinated and brominated additives generates unintentionally produced POPs (U-POPs) such as HCB, PeCB, PCDD/Fs, PBDD/Fs and dl PCBs. All forms of burning plastic waste, including their use as fuel, should be banned as this releases POPs into the environment. Wastes containing high levels of POPs can be treated by non-combustion technologies, which destroy POPs and do not generate new POPs.

In agreement with previous studies, the present study shows that children toys, hair accessories, office supplies, and kitchen utensils found on the Kenyan market are affected by unregulated recycling of e-waste plastics, which carry toxic brominated flame retardants (BFRs) into new products. To stop this practice, stricter measures to control BFRs in products and waste need to be set and enforced.

The results of this study also highlight that the new global Plastics Treaty should focus on the chemical content in plastics.

Figure 1: The highest levels of dl-PCB in eggs and related sources measured as part of IPEN studies (striped bars) and other scientific studies (filled bars). (More information, including references to individual sites are compiled in Table S3 in supporting information to the study published in 2022). Source: (Petrlik, Bell et al. 2022).