The EU should urgently address the risks of exposure to chemical cocktails

We, our children, wildlife and the wider environment are constantly exposed to a complex cocktail of known and suspected harmful chemicals through air, water, food, consumer products and other routes. Decades of research have demonstrated that combined exposure to several chemicals can result in toxic cocktail effects [1,2,3]. Yet most chemical safety regulations ignore this fact and assess chemicals one by one, in isolation [3,4]. **We are not properly protected from the impacts on our health of real-life exposure to cocktails of chemicals - neither is the wider environment.**

The EU’s Chemical Strategy for Sustainability in 2020 recognised that exposure to harmful chemicals is “a threat to human health” and that chemical pollution is “one of the key drivers putting the Earth at risk, impacting and amplifying planetary crises such as climate change, degradation of ecosystems and loss of biodiversity” [5]. As global chemical production grows [6] and the number of chemicals in use around the world multiplies [7] we face enormous challenges to our ability to keep humans and the wider environment safe from the impacts of exposure to cocktails of harmful chemicals.

**The EU should act urgently. In CHEM Trust’s analysis there are workable and effective policy solutions available to address this complex problem, and the EU should now adopt them.**
Within our homes and our daily lives we are exposed to hundreds of chemicals from multiple sources, such as flame retardants in soft furnishings, phthalates in plastic food packaging, or PFAS in cosmetics. Yet most chemical safety regulations completely ignore the fact that we are being simultaneously exposed to a cocktail of hundreds of substances from a diversity of sources.
We are all exposed to mixtures of chemicals

A huge range of currently-used chemicals are detected in humans, wildlife and the environment, including flame retardants, pesticides, water repellents, plasticisers, as well as persistent residues of highly toxic chemicals banned decades ago. Scientists have measured dozens to hundreds of chemical pollutants in our bodies and the environment, e.g. in rivers [8], the dust in our houses [9], our bodies [10] and those of new-born babies [11].

The chemicals that have been detected are the tip of the iceberg as studies of chemicals in humans and environmental samples are always restricted to a limited selection of chemicals. The true chemical burden on our bodies and the environment is therefore unknown, so we have no idea about the full composition of the chemical mixture we are exposed to daily.

Mixtures matter

Many of the chemical substances we are exposed to are individually known to cause harm to human health, wildlife and the environment. But in reality we are not exposed to individual chemicals one at a time, and there is now clear evidence from decades of research that these chemical exposures can add together, reinforcing their negative impacts [1,2,3].

Studies show that chemical mixtures present in the environment (‘real-life mixtures’) can affect a range of biological processes – from the hormonal and neurological systems of children [12] to the immune systems of marine mammals [13]. Crucially, adverse impacts can be observed in cases where the individual chemicals in the mixture are present at or below the level considered safe [3]. The effect(s) of the combined exposure to multiple chemicals from multiple routes can be called the cocktail effect, combination effect, or mixture effect.
Chemical pollutants related to human activities find their way into the natural environment via many routes: effluents from wastewater treatment plants connected to households, hospitals, and businesses; runoff from fields, roads, and airports; air and water emissions from factories and waste treatment sites. Chemical pollutants accumulate in soils, rivers and the deep ocean, exposing wildlife throughout the food chain to a cocktail of hundreds of substances.

1. Everyday chemicals from clothes, detergents, cosmetics etc. emitted in sewage water from households
2. Pharmaceuticals emitted in sewage water from hospitals
3. Chemical contaminants discharged into rivers and the sea from wastewater treatment plants
4. Pesticides, fertilisers and biosolids contaminate soil, rivers, and groundwater from agriculture
5. Veterinary drugs and rodenticides used in farms contaminate soil, water, and fauna
6. Car tire leachates contaminate soil and rivers from road runoff
7. Industrial chemicals emitted into the air and wastewater from industrial sites
8. PFAS contaminates soil and water from firefighting foam used at airfields
9. Synthetic chemicals contaminate soil and water from landfill leachates
10. Chemical pollutants emitted into the air from incinerators
11. Pesticides and veterinary drugs contaminate the sea from aquaculture farms
12. Process chemicals, such as lubricants, contaminate the sea from oil rigs
13. Chemical contaminants, such as surfactants and biocides, are released into the sea from shipping

Figure 2 - Chemical pollutants in the environment
Mixture toxicity means that risks are underestimated

EU regulators have spent decades developing assessment processes for individual chemical substances in isolation, and it is accepted that these processes still need improvement. However the reality is that people and wildlife are exposed to multiple chemicals at the same time. A few regulatory processes assess exposure from a combination of chemicals, but this is usually limited to chemicals from the same regulatory silo, for example, pesticides. This ignores the fact that a person or a fish will be exposed to pesticides and other chemicals.

The true risks resulting from combined exposure to numerous chemicals, even at low levels, are being vastly underestimated. This means we lack proper protection from our real-life exposure to a large number of different chemicals.

Trying to predict mixture toxicity

Scientists have developed models to estimate the toxicity of mixtures of known composition [14,15]. When all chemicals present are known, as well as their concentration and effects, it is then possible to estimate the toxicity of the mixture and predict the risk in various exposure scenarios.

However, with thousands of chemicals currently in use and many unidentified substances present in the environment and our bodies, predicting the risk from exposure to real-life mixtures presents an extraordinary challenge. In the words of the Chemicals Strategy for Sustainability, it is “not realistic nor economically feasible to specifically assess and regulate an almost infinite number of possible combinations of chemicals” [5].
A pragmatic solution: the Mixture Assessment Factor (MAF)

Because of the difficulty in assessing combination effects in detail, scientists have developed simpler and more general solutions, with the Mixture Assessment Factor (MAF) now seen by many scientists and regulators as the only feasible approach for controlling risks from chemical mixtures [16].

Put simply, the ‘safe’ level of exposure that is determined for an individual chemical is then divided by an extra uncertainty factor, the Mixture Assessment Factor. The MAF acts as a safety net to account for the mixture toxicity that would result from combined exposure to this chemical with other known and unknown chemical substances. In CHEM Trust’s view, the MAF is a pragmatic and effective way to manage the reality of mixture exposure.

There is a debate about the best value for the MAF, and in CHEM Trust’s view, the factor must be high enough to truly increase the level of protection of human health, wildlife and the environment from real-life chemical cocktail exposures.

According to our analysis, considering 1) the vast number of chemicals from various sources found in wildlife and people, 2) their respective contribution to mixture effects, 3) the uncertainties related to the contribution of unknown chemicals, we consider the MAF should be 100.

Time for the EU to act

The science is clear – people and the environment are exposed to mixtures of chemicals and the impacts from the combined exposures have been underestimated until now.

EU chemicals regulation must protect human health and the wider environment from the harmful impacts of combined exposures to multiple chemicals, whether they are pesticides, pharmaceuticals or industrial chemicals. This is not the case at the moment and this gap in protection must be closed now to act on the scientific warnings and to deliver the promises of the EU to work towards a “toxic free environment” as laid out in the 2019 European Green Deal [17].

What is at stake is the health of current and future generations. Tackling chemical cocktails is also part of the challenge of addressing the biodiversity crisis.
CHEM Trust’s recommendations for EU chemicals policy on mixtures

Our analysis is that the following policy measures are the minimum the EU should be doing to address these risks:

1. Incorporating mixture assessment into all EU chemical regulations

- A Mixture Assessment Factor (MAF) should be incorporated in all chemical assessments. We assess that a factor of 100 would be optimal to cover the contributions of different chemicals to mixture toxicity, the different sources of exposure, and additional uncertainties related to unknown chemicals.

This MAF should be introduced to the main EU industrial chemical law REACH as soon as possible, as part of implementation of the Chemicals Strategy for Sustainability.

- A legal requirement for mixture assessments should be integrated into other EU chemicals laws during upcoming revisions, including those stipulated by the Chemicals Strategy for Sustainability. It is essential to integrate approaches to address mixture toxicity in all relevant EU laws and in many cases the best option will be a MAF approach. Where targeted mixture assessments are used they must be improved, e.g. by widening the number and scope of substances covered and by introducing more transparency about inherent uncertainties and limitations.

2. Identify and control the use of the most hazardous chemicals, to reduce the quantity of hazardous chemicals we are exposed to

- There should be more resources put into biomonitoring and environmental monitoring programmes in the EU, and harmful chemicals found in humans and the wider environment should be prioritised for regulatory action. It is particularly important to reduce exposure to persistent chemicals and endocrine (hormone) disrupting chemicals.

- Regulatory processes for controlling the use of chemicals must become faster and more protective. One way to do this is through grouping of chemicals for regulatory measures. Chemicals from a group (e.g. bisphenols, phthalates, PFAS, brominated flame retardants) should be regulated together under REACH, and in other chemical-related laws to speed up substitution with safer alternatives.
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This summary was produced by CHEM Trust – a collaboration between CHEM Trust, a UK registered charity, and CHEM Trust Europe eV, a charity based in Germany – working at UK, EU and international levels to protect humans and wildlife from harmful chemicals.

CHEM Trust engages with the scientific, environmental, medical and policy communities to improve the dialogue concerning the role of adverse effects of chemicals in wildlife and humans and to harness a wide coalition to drive improved chemicals policy and regulation.

Authors

A first draft of the report was written by Rye Howard, an environmental public health scientist with a broad background in epidemiology, toxicology, and research translation.

Further drafts of the report including the policy recommendations were written by Dr Ninja Reineke, Dr Julie Schneider and Pia Juul Nielsen of CHEM Trust, informed by the state of the science, the views of the scientists and CHEM Trust’s experience of following chemicals policy development for more than two decades.

Scientific review

The scientific content of this report has been peer reviewed by Dr Olwenn V Martin, a Lecturer in Global Challenges at Brunel University, London.

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