Scientific Facts on

Water Disinfectants

& disinfectant by-products

Source document:
IPCS (2000)

Summary & Details:
GreenFacts

Context - To protect drinking water against germs and fight disease transmitted through water, disinfectants such as chlorine, chloramines, ozone and chlorine dioxide are used. These disinfectants can react with natural material in the water to form certain unwanted by-products, which raise health concerns.

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This Digest is a faithful summary of the leading scientific consensus report produced in 2000 by the International Programme on Chemical Safety (IPCS):
"Executive Summary of the Environmental Health Criteria (EHC) 216: disinfectants and disinfectant by-products"

The full Digest is available at: https://www.greenfacts.org/en/water-disinfectants/

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- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. What disinfectants and by-products are we talking about?

1.1 Disinfectants such as chlorine, chloramines, ozone and chlorine dioxide are very important to protect drinking water against germs and fight disease transmitted through water. However, they can also react with natural material in the water to form unwanted by-products, which can be of concern to public health.

1.2 The formation of by-products depends on the disinfectant used, the chemical and physical characteristics of water and the treatment conditions.

1.3 While all disinfectants form by-products, different disinfectants form different by-products, for instance:

- Chlorine can form halogenated by-products (i.e. that have chlorine or bromine incorporated into their structure) such as trihalomethanes and haloacetic acids.
- Ozone can form bromate.
- Chlorine dioxide can form chlorite and chlorate.
- All disinfectants form a variety of oxidation products that have not been well characterized.

1.4 There are several options to reduce the amount of disinfectant by-products in drinking water.

2. What happens to disinfectants and their by-products when ingested or inhaled?

Disinfectants still present in drinking water will react with saliva and stomach content to form disinfectant by-products similar to those produced in water.

The way disinfectant by-products are metabolised and eliminated depends on the by-product. Some will change to a harmless form but some can be converted into a form that can affect health.

3. How can disinfectants and their by-products affect health?

Disinfectants in drinking-water do not raise health concerns themselves at the levels used but some of their by-products do:

- Some chlorine by-products can harm the liver and kidney of laboratory animals given high doses and may even cause tumours. They do not appear to affect reproduction except at very high doses.
- Chlorine dioxide by-products can affect the red blood cells.
- Ozonation by-products can cause tumours in animals at high dose.

4. Have disinfectants and their by-products affected human health?

4.1 Some studies in human populations seem to indicate that chlorinated and chloraminated drinking-water may cause cancers of the bladder, colon and rectum, but the studies are not conclusive. Neither chlorinated nor chloraminated drinking-water appear to cause cardiovascular disease in humans. Other disinfectants have not been studied.

4.2 There is no convincing evidence that water chlorination can harm pregnancies or cause reproductive problems.

5. What are the risks posed by disinfectants and their by-products?

5.1 The World Health Organization (WHO) has set intake limits for most disinfectants and by-products. These are used for developing the WHO drinking water guidelines that are, in turn, used by many countries as a basis for their drinking water standards.

5.2 Several milligrams of disinfectant per litre of water are typically employed in treatment plants, but what arrives at the tap is generally considerably less and well below the WHO guidelines. The concentration of disinfectant by-products varies according to the properties of the water and the amount of natural organic matter it contains.

5.3 Potential human health effects would depend on both the concentration of disinfectant by-products and the length and timing of exposure. However, it is difficult to measure actual exposure levels and to take into account all possible risk factors.

5.4 Studies on human populations are useful but those on disinfectant by-products in particular have been difficult to interpret. Available studies are insufficient to establish that water disinfectants and their by-products affect health.

6. Conclusions

Since disinfection is a very important barrier to waterborne disease, it should never be compromised in attempting to control disinfection by-products. Studies to date do not provide sufficient evidence to say that exposure to disinfectant by-products actually causes cancer or affects reproduction.

However, it is prudent to take steps to limit the exposure to disinfectant by-products where this can be achieved without compromising disinfection effectiveness.