New types of chemicals found in Danish drinking water

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Measurements reveal more than 400 different chemicals in water from a single Danish waterwork. Several of the compounds can have adverse health effects. According to the University of Copenhagen analytical

chemists behind the study, monitoring needs to be broader and not solely focused on PFAS and pesticides. The techniques to do so already exist.

Despite a massive focus on PFAS substances and pesticide residues in Danish drinking water, little attention is paid to the hundreds of other chemical compounds in our groundwater.

Analytical chemists at the University of Copenhagen, in collaboration with Danish water and wastewater company Novafos, have taken broad measurements of substances in drinking water from three waterworks.

The researchers detected more than 400 different chemical compounds in water from a single waterworks. More than 100 compounds were found in water from each of the other two. But how many of these compounds are naturally occurring versus man-made remains unknown. At least nine of them are of particular concern to the researchers. Among other things, they can be harmful to organs and be carcinogenic and endocrine disrupting.

"Among the compounds we found were TCP, a toxic chlorinated substance used as an insecticide that can be carcinogenic, and melamine, which is used in the plastics industry and can damage the bladder and kidneys. Other compounds that can be harmful to health when in high-enough concentrations were also detected. We also measured many other chemicals that no one knows the toxicity of," says analytical chemist Selina Tisler, an assistant professor at the Department of Plant and Environmental Sciences and first author of the study, published in the journal *Environmental Pollution*.

As far as is known, five of the compounds detected have never before been reported in groundwater anywhere in the world. These include benzothiazole, a compound used in car tires and on artificial turf pitches, that has shown high toxicity in cell tests. The researchers report that an

additional five compounds have never been found in Danish groundwater. These include the above-mentioned TCP (2,4,6-trichlorophenol) and TFMS (trifluoromethane sulfonic acid), which are used in firefighting foams and belong to the large group of PFAS substances. A recent study shows that these cause physiological changes and disturbances in the gut bacteria of mammals.

The researchers strongly emphasize that, as for now, they only have indications of how large the concentrations of individual chemical compounds are. Therefore, no health risk can yet be established with regards to tap water consumption. According to Novafos, water from each of the three waterworks complies with all applicable regulations.

Monitoring needs to be broader

The researchers used liquid chromatography-high resolution mass spectrometry to detect a large portion of the various chemical compounds in each water sample. This technology allowed them to detect compounds that standard techniques currently used for screening groundwater are unable to detect.

According to the researchers, the major weakness in screening today is that public agencies only require monitoring for a limited number of predetermined substances.

"Taking action against PFAS substances and pesticides is definitely important. But one should also be after a broader overview of the chemicals in our environment that eventually will end up in our bodies. And, we have the techniques to help water utilities and agencies accomplish this task," says Jan H. Christensen, a professor at the Department of Plant and Environmental Sciences and the study's lead author.

Some compounds can be treated away, but...

In many countries, groundwater destined for consumption goes through a treatment process. In Denmark, groundwater is usually just oxygenated and filtered before being pumped out to people's taps.

To study the effect of treatment, water from the three waterworks was treated using UV light (known as AOP purification), a commonly used purification technique in other countries.

The study demonstrates that treatment *can* make a big difference. On average, this method resulted in the removal of 70% of the chemical compounds. But at the same time, many new substances, so-called transformation products, were also formed as a result of UV light treatment. In fact, nearly as many compounds were created as the cleaning removed.

After treatment, the water from one waterworks was filtered through biological activated carbon (BAC) filters in four stages. Here, the vast majority of compounds were captured—but not all of them:

"While thorough filtration collects both the majority of newly formed compounds and some of those that were in the water from the beginning, a range of problematic compounds still slip through. These include fluorinated compounds like PFAS and PFAS-related compounds," says Selina Tisler.

Nevertheless, the two chemists believe that drinking water should be treated in Denmark. Selina Tisler points out:

"Our study demonstrates the complexity of treatment. For example, we can see that this treatment technique was effective in removing some of the pesticides, but didn't work on PFAS compounds. So it's important to

make use of different treatment techniques depending on which substances are being prioritized for removal. Indeed, there is not necessarily one treatment process that works on all chemical compounds."

Stop using the most toxic compounds

According to Jan H. Christensen, waterworks company Novafos' monitoring initiative is commendable:

"Initiatives like this are needed to more thoroughly measure whatever is hidden in our groundwater and learn how to best reduce the load of contaminants. It's good to see the water utility sector being proactive and taking responsibility for ensuring clean drinking water for consumers," says Jan H. Christensen.

But he highlights that we cannot simply rely on cleansing the problem away:

"Once you have an overview of which substances are out there and in what concentrations, it can help to prioritize which wells should remain open and which should be shut, as well as which treatment technologies would be most effective. But beyond that, we need to attack the root of the problem. We need to stop using the most toxic and difficult-to-degrade compounds and thereby eliminate the source itself. And then we should not use, as often happens, alternative compounds that turn out to be just as harmful—and sometimes even more so," says Jan H. Christensen, who concludes:

"Because there are some extremely tenacious chemical compounds that are very difficult to remove from our drinking water once they get there, regardless of how and to what extent the water is treated."

More information: Selina Tisler et al, Non-target screening of micropollutants and transformation products for assessing AOP-BAC treatment in groundwater, *Environmental Pollution* (2022). DOI: 10.1016/j.envpol.2022.119758