Mapping Microplastics in Norwegian Drinking Water

A summary of results and evaluation of suspected health risks

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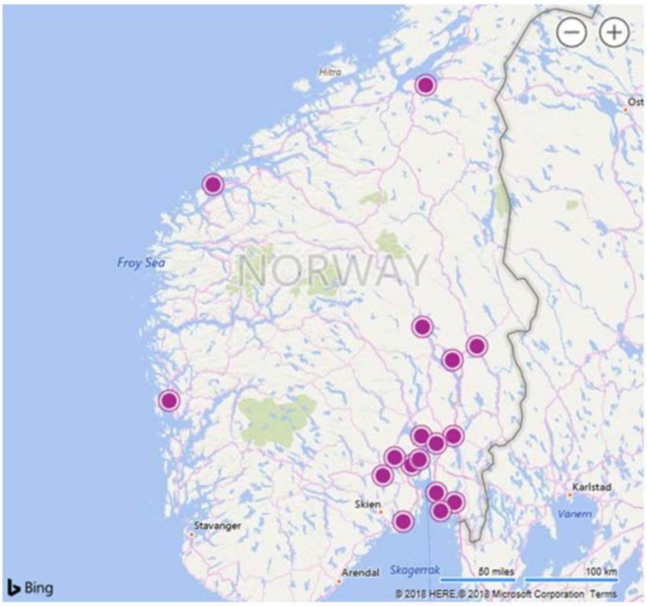
The study

Background and the study sites

In the near past, a few articles in the media about the presence of microplastic particles in drinking water gained attention. The studies were generally criticized by experts as not reliable, due to a lack in proper methodology. Despite that, the Norwegian water sector takes responsibility and is interested to gain more reliable information about the suspected occurrence of microplastic particles in Norwegian drinking water. On behalf of the national water association Norsk Vann, the Norwegian Institute for Water Research (NIVA) carried out a study in which special attention was paid to minimize the potential contamination of the samples and to obtain an improved procedure for analysis. The twenty-four waterworks considered for sampling, supply a large part of the Norwegian population and were selected such that the probability for the raw water to contain microplastic particles was considered as high, due to an exposed environment. Additionally, a few waterworks producing drinking water from groundwater were sampled. Groundwater is generally low in particle concentrations and therefore not expected to contain microplastic particles at all. Besides the raw water, produced drinking water after treatment and drinking water from the distribution system were sampled to understand whether water treatment removes microplastic particles and whether the material of the distribution system has an impact on the concentration of such particles.



Methodology

Special emphasis was put on improvements in sampling technique and the analysis of the water samples. The results by others, previously presented in different media, had been obtained from samples where sampling had been done by non-professionals who were not aware of special attention to be given when sampling microplastics in water and at very low concentrations. In our study, the sampling was done by professionals. In addition, they were provided a special sampling procedure to minimize contamination of the samples by microplastics from air during sampling.

Sampling was done in triplicate and in 1 L volumes. All samples were coded upon arrival at NIVA and before they were transferred to NIVA's laboratory for analysis. This avoided bias, as the analysing person did not know which bottles of a triplicate belonged together and which samples belonged to the respective waterworks. Special attention was given to minimize possible contamination from laboratory air during analysis. Additionally, for quality control, blanks of water that had been filtered and did not contain any particles, was analysed frequently.

In addition, bottles with water that was free of particles were exposed to indoor air during 24 hours, and analysed for microplastic particles as all other samples.

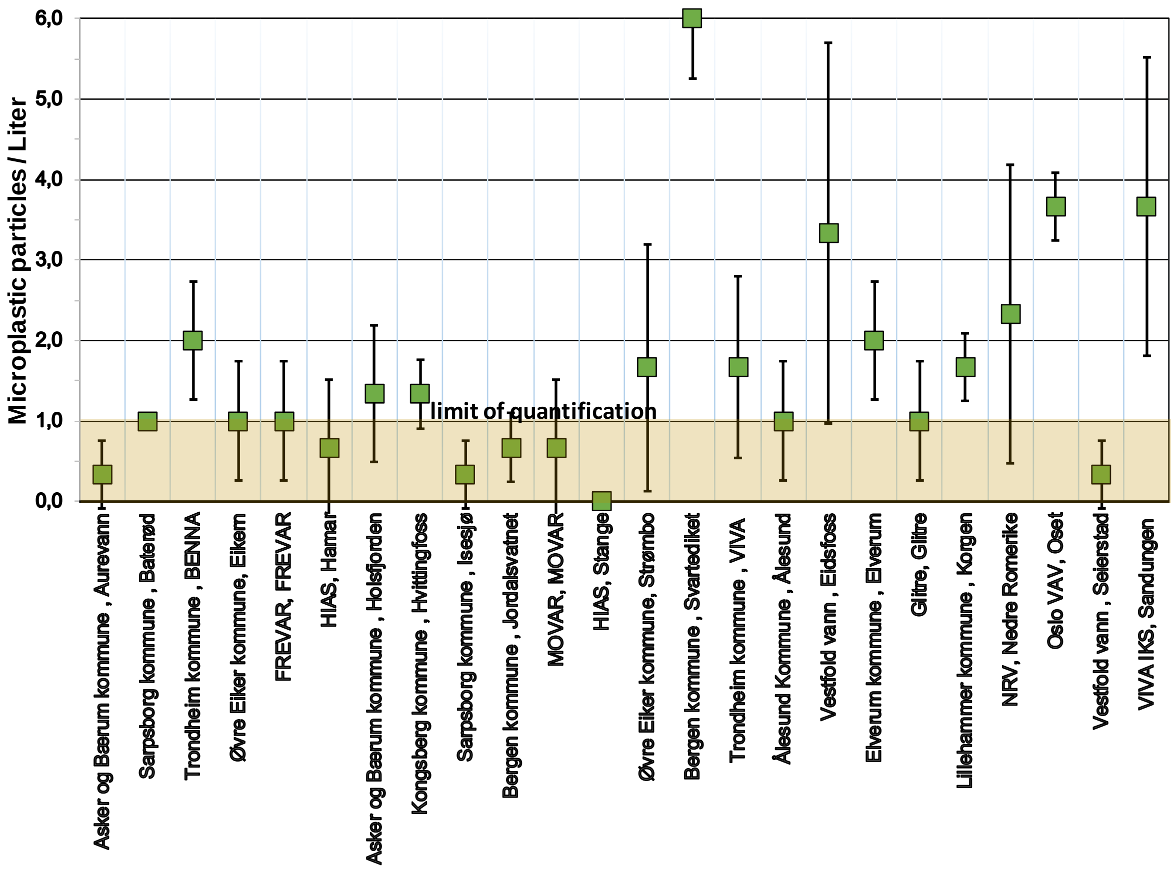
Results

The analysis of 105 blank samples showed that a limit of quantification of one particle per litre must be considered. We report analysis results with 67 % confidence intervals. If these confidence intervals overlap with the limit of quantification when using our method, then the sample must be reported as containing less than 1 particle (i. e. below the limit of quantification).

All raw waters that were sampled at the intake of the 24 water works contained strikingly low concentrations of microplastics: In 20 out of 24 samples, the concentration found was reported below the limit of quantification. Only four of the raw water samples showed average concentrations of up to 2.7 particles per litre with error bars slightly above the limit of quantification.

For the drinking water after treatment in the respective 24 water works, the microplastic particle concentrations were even lower. In 23 out of 24 samples the concentrations were reported below the limit of quantification. In the only one sample which was above that limit, the average in three bottles was 2.4 particles per litre.

For drinking water from the distribution system, in 19 out of 24 samples the concentration of microplastic particles was below the limit of quantification. The results are shown in the diagram below. In only five samples the concentration was above the limit of quantification. They contained between 2.0 and 3.7 microplastic particles per litre, on average from three bottles. In one sample an average concentration of 6 particles was found, but that was attributed to rough sampling conditions in an environment where contamination of the sample from air had to be expected. It has to be noted in general that the sampling conditions for drinking water from the distribution system were not as controlled as at the waterworks.



Originally particle free water exposed to indoor air during 24 hours showed considerably higher concentrations of microplastic particles. The difference was clearly higher than what can be attributed to the limit of quantification. The exposure to indoor air during 24 hours added about 4 microplastic particles per litre of water. This is by far more than was found in the Norwegian drinking water.

Potential health risks

We are exposed to plastic particles

Humans are exposed to plastic particles such as nano- and microplastics through foods and air. Currently, no analytical methodology for measuring nanoplastics exists. However, microplastics have been found in fish and seafood, beer, honey and bottled water. Fish and seafood contain the highest amounts of microplastics. Most of the microplastics are located in the gastrointestinal tract and therefore cleaned seafood and fish, where the gastrointestinal tract are removed, will only contain small amounts of microplastics. Whereas shellfish, such as mussels and oysters, where the gastrointestinal tract is not removed, can be a source of larger amounts of microplastics.

Plastic waste and plastic particles are a threat to the environment

In recent times, there has been a focus on harmful effects of plastic waste, including nano- and microplastic particles. It has been shown that microplastics is harmful to wildlife both below and above the sea surface and that they can be transferred along the food chain. However, there has been less research on the potential hazardous effects of nano- and microplastics in humans.

Human health effects are unknown

In 2016, the European Food Safety Authority (EFSA) published a report on microplastics and nanoplastics in food with particular focus on seafood. EFSA concluded that there was insufficient data on the occurrence, toxicity and uptake to conduct a full risk assessment. Currently, it is therefore not possible to conclude whether exposure to nanoplastics and microplastics are hazardous to humans. The Norwegian Scientific committee for Food and Environment is currently working on a summary of the status of knowledge of the occurence of microplastics and potential health implications, which will be published in 2019.

The majority of the microplastics are not absorbed in the body

Particle size is likely to be the most important factor in determining the extent and pathway for uptake, although, composition, surface charge and hydrophilicity are also thought to affect the uptake. No in vivo human data on the uptake of microplastics are available. However, existing literature in mammals indicates that microplastics >150 µm are not absorbed, therefore only local effects on the immune system and inflammation are expected for these particles. For particles <150 µm it is likely that only a fraction is absorbed in the intestine and causing systemic exposure.

Microplastics can contain contaminants and pathogenic bacteria

Microplastics can contain additives, such as bisphenol A and phthalates. It has also been shown that microplastics can contain relative high amounts of contaminants such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Calculations have shown that even a large portion of mussels, which are eaten without removal of the digestive tract, will only have a small effect on the exposure to additives and contaminants. In addition, it has been shown that pathogenic bacteria can colonise the microplastics. However, the consequences to human health are unknown.

The drinking water in Norway is safe

The current survey shows that there are low levels of microplastics in Norwegian drinking water, both before and after water treatment. Due to methodological limitations, only microplastics of 100 µm and above have been measured. There is a need for development of standardized analytical methods to detect and identify plastic particles of 100 µm and smaller to verify that the drinking water also only contain low levels of these smaller plastic particles.

At present, there are little evidence of negative health effects in humans due to exposure to plastic particles, although further research is necessary to rule out that these particles are not hazardous to humans. Considering the low amounts of microplastics measured, the consumption of tap water will only to a small extent contribute to the total exposure of microplastics. Therefore, there is no need for concern for consumption of tap water in regard to exposure to microplastics and human health effects. Nevertheless, since plastic waste and plastic particles have proven to be a major environmental threat, it will be important to reduce the release of plastic in the future.

References

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