Bacteria from the tap

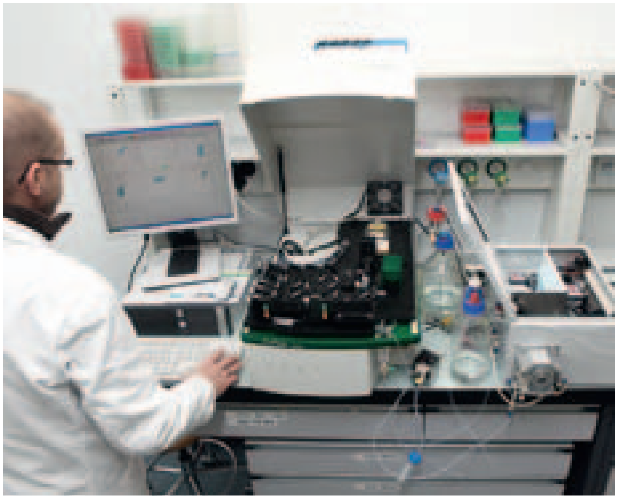
Chemical compounds released from certain plastic pipes can promote bacterial growth and adversely affect drinking water quality. The suitability of materials for water contact can be assessed with a new analytical procedure.

Drinking water is not sterile as it passes through public distribution systems – and still less so when it comes out of the tap. In fact, it contains large numbers of microorganisms. In the vast majority of cases, however, such bacteria are harmless and even desirable, according to Stefan Koetzsch of the Environmental Microbiology department: "They normally ensure that the water is microbiologically stable, preventing the proliferation of pathogens."

But in certain plastic water pipes, including those generally used in household installations, the balance of the natural microbial community can be disturbed. Chemical substances – e.g. additives such as plasticizers or stabilizers – can be released from the plastic material in a process known as migration. Typically, the substances released are organic carbon compounds, which serve as nutrients and thus promote the growth of microorganisms in water. These changes can impair the odour and taste of drinking water and may even pose risks to health.

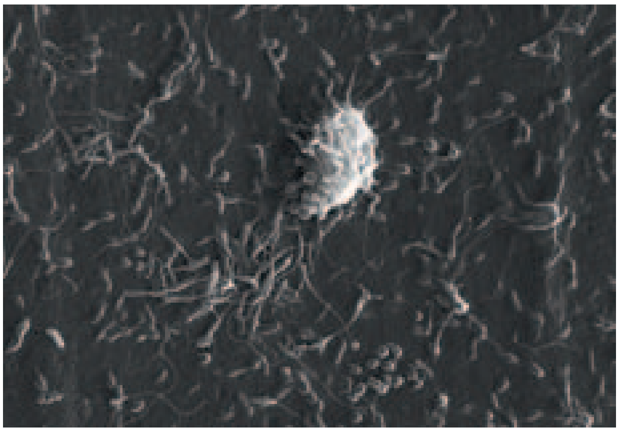
Materials of concern

In order to assess the suitability of plastic materials for water contact applications, Koetzsch and his colleagues have developed a combination of methods known as "BioMig". Various tests are used to determine the amount of organic carbon leaching into water from plastic samples, and to what extent these compounds support the growth of microorganisms. Koetzsch explains: "With BioMig, we can estimate the influence of particular plastics on chemical and microbiological drinking water quality."



Gesa Lüchinger

Flow cytometry is used to determine microbial cell concentrations and community composition in water supplies.



Klaus Marquardt

Biofilm on a plastic surface: certain materials can promote bacterial growth in distribution systems.

The environmental microbiologists applied the BioMig procedure to test three widely used piping materials approved for drinking water contact – radiation cross-linked polyethylene (PE-Xc), peroxide cross-linked polyethylene (PE-Xa) and epoxy resin, which is frequently used in repair work as a lining for metal pipes. To analyse migration behaviour, samples of the materials were placed in water and the leaching of organic carbon compounds was measured over several cycles. The best-performing material was PE-Xc, from which on average a total of 1 milligram of carbon per litre was released. In addition, this was almost completely degraded by microorganisms. Next came epoxy resin, with 1.3 milligrams per litre; here, too, the carbon was almost completely degraded. The highest migration of carbon – 7.4 milligrams per litre – was observed with PE-Xa; here, the degradation rate was less than 5 per cent. Koetzsch comments: "High migration combined with limited biodegradation is problematic, as it's not clear precisely what carbon compounds enter the water and are then ingested by consumers."

Strong bacterial growth

In a further test, the potential of the plastic materials for biofilm formation was evaluated: samples were left in the same water for 2 weeks and bacterial growth was measured. Microorganisms proliferated on each of the three materials tested, with the number of bacterial cells per square centimetre ranging from 30 million (PE-Xc) to 50 million (epoxy resin).

Comparable results were obtained when bacterial growth was measured in simulated and real-life household installations. In the plumbing system of a new residential building in Winterthur, bacterial cell counts in stagnant water (i. e. water residing in pipes for 15 hours without flushing) were found to be up to 100 times higher than in the local water supply. After flushing, levels returned to normal. The composition of the microbial community was also altered in stagnant water.

According to Koetzsch, a safety limit for bacterial cell concentrations in water has not been defined. He also points out that the absolute concentrations are not of crucial importance: "Treated lake water can easily contain 100,000 bacterial cells per millilitre because it's richer in nutrients than, for example, groundwater." What is of greater concern than high, but stable, cell concentrations, in his view, is an abrupt rise in these levels within a distribution system. For this may indicate a disturbance of the microbiological equilibrium, possibly associated with the proliferation of pathogenic organisms.

Koetzsch emphasizes: "Even though it contains microorganisms, drinking water in Switzerland is generally of very high quality." Public water supplies are well monitored and microbiologically stable. This means that drinking water harbours an unvarying population of harmless bacteria. By feeding on organic matter, these bacteria prevent the spread of any pathogenic organisms which may enter the water supply as a result of contamination.

Tighter plumbing regulations

Koetzsch does, however, have one reservation with regard to the quality of drinking water – the "last mile" of the distribution system, which is the responsibility of individual property owners. As he points out, while industrial standards exist for manufacturers concerning the quality and migration potential of plastic piping, they are not legally binding: "Controls go no further than each household's water meter. So, as a rule, nobody can guarantee the quality of drinking water in buildings."

Koetzsch would like to see greater attention paid to the issues of migration and bacterial growth in the plumbing sector. He believes that action is required, for example, with regard to the pressure tests specified for newly installed water pipes. Here, water contaminated with unwanted microorganisms can easily enter a household system. Koetzsch calls on the plumbing sector to place greater emphasis on hygiene and to use membrane filters to retain microorganisms in pressure testing: "Because if unwanted, possibly pathogenic, organisms get into a system at the outset, they find excellent conditions for growth in the new plastic pipes leaching organic carbon."

Koetzsch also suggests that, prior to first use, new pipes should be flushed several times with hot, chlorinated water. The effects of this procedure would be twofold: any microbiological contaminants could be removed, and some of the organic carbon which tends to leach from new pipes (migration being much reduced after the first few months) could be flushed out of the system at this stage.

Flow cytometry method in the Swiss Food Compendium

The flow cytometry-based method developed by Eawag for the analysis of drinking water has been included in the Swiss Food Compendium. This publication, overseen by the Federal Office of Public Health, is an official compilation of recommended and mandatory analytical methods used for quality control of foodstuffs, additives and articles of daily use. In the assessment of the microbiological quality and safety of drinking water, flow cytometry provides much more realistic results than the legally specified heterotrophic plate count (HPC) method. HPC can only detect bacterial cells which grow on solid nutrient media (agar plates) – around one per cent of all the microorganisms present in a water sample. In addition, flow cytometry is much quicker than the conventional method: results are available after a quarter of an hour, whereas HPC analysis can take several days or even weeks, depending on the individual pathogen.
In the analytical procedure known as "BioMig", flow cytometry is used to determine microbial cell counts and community composition in distribution systems.

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