Validation and practical application of continuous monitoring of microbial water quality of drinking water

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Introduction

Traditionally, microbiological drinking water quality is monitored by water samples taken once every day, week or month. As it has been shown that the microbiological water quality can change rapidly, or for short periods, we studied whether two microbiological water quality sensors, with an analysis time of 30-60 minutes, could be better and more reliable in describing the microbiological water quality than traditional methods.

Methods

Unchlorinated drinking water was sampled at two distribution systems and three production locations in the Netherlands, serially diluted and measured for enzymatic activity using the BACTcontrol sensor (microLAN, The Netherlands) and for cell counts using the BactoSense sensor (bNovate, Switzerland). Results were compared to cell counts (flow cytometry and microscopy) and ATP concentrations measured in the laboratory.

In pilot setups, both sensors continuously measured the microbiological water quality for 2–3 months at three drinking water production locations. Results were compared to operational parameters to better understand the microbial dynamics.

Results

Serially diluted drinking water was reliably measured with the BactoSense and to a lesser extent with the BACTcontrol (Figure 1). Drinking waters with a higher biomass were measured correctly. The other methods (ATP, microscopy, BACTcontrol) did show a dilution, but not the expected concentrations, as some values were close to the lower detection limit. Statistical correlation was strong between BactoSense, FCM and microscopy for all locations. BACTcontrol strongly correlated with BactoSense and FCM for one location.

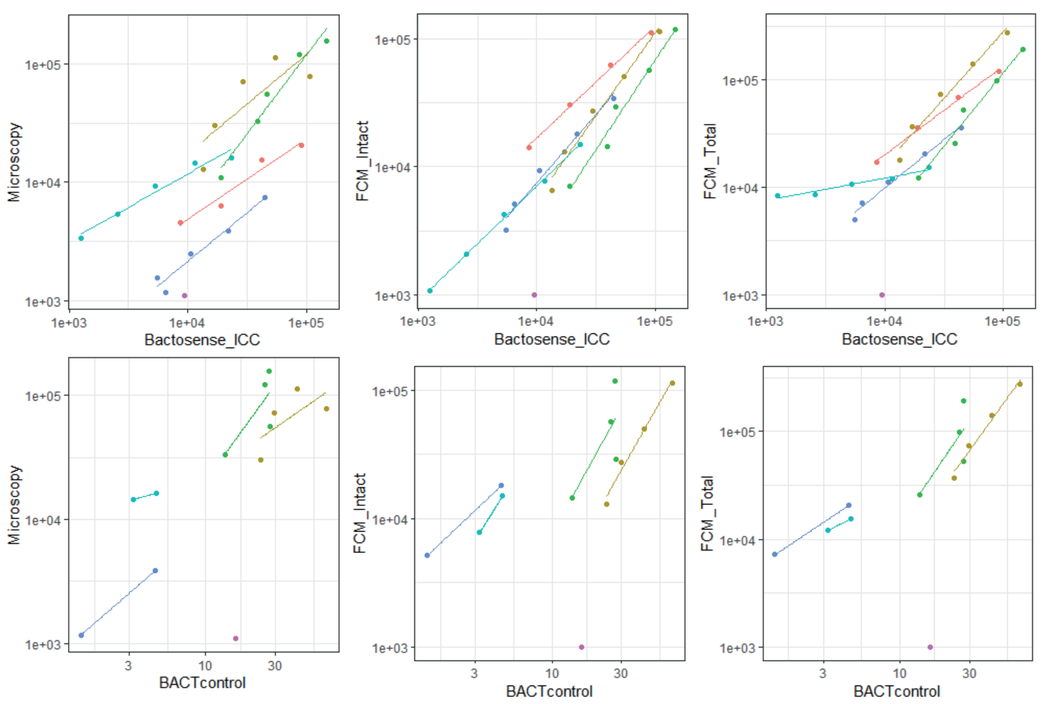

Figure 1. Correlation graphs comparing BACTcontrol and ICC analysis (intact cell count) of the BactoSense to laboratory parameters (microscopy, FCM_intact, FCM_Total) on dilution series of unchlorinated drinking water from different locations. ATP not shown: nearly all data points are below the detection limit.

Continuous measurements with the BACTcontrol and BactoSense at the production locations showed similar trends, but also different trends, between the sensors. Due to technical errors, several datapoints were lacking for the BACTcontrol. Depending on the pilot location some of the aberrations from baseline could be linked to operational parameters or other factors. But many could not be linked.

Drinking water of groundwater production location with full-stream RO. Variation in enzymatic activity and cell numbers were probably caused by: non-optimal ammonium removal (1, 2), non-optimal ammonium removal and cleaning of aeration tower (3), flushing of aeration tower (4) and non-optimal performance of aeration tower (5).

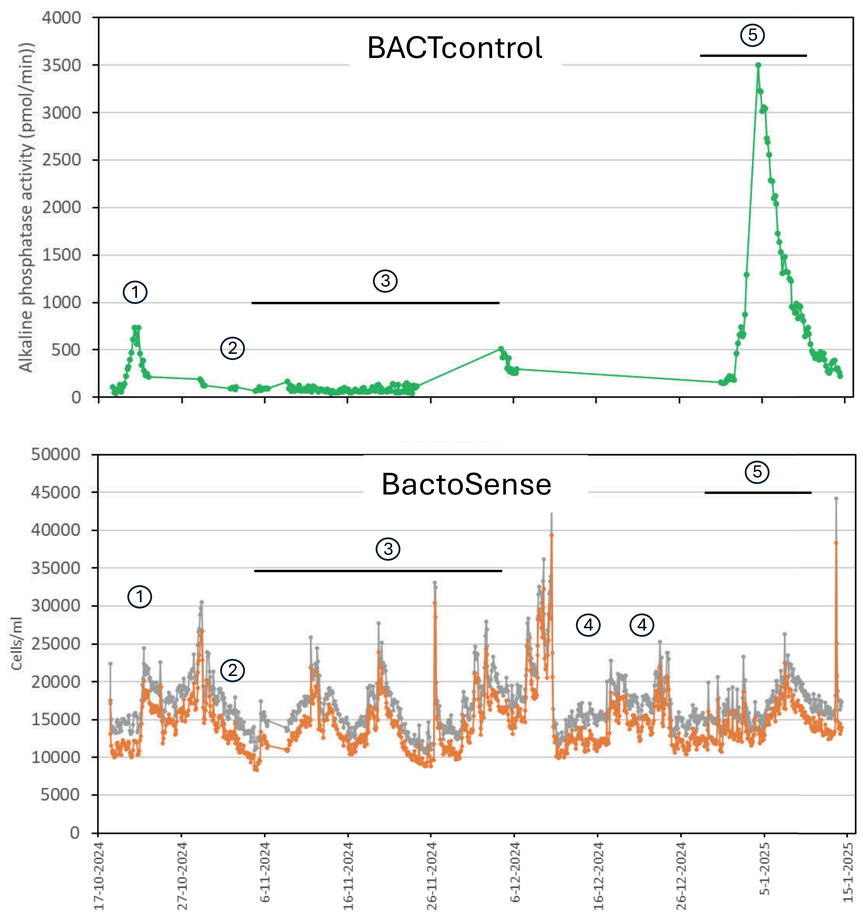

Figure 2. Continuous measurements with BACTcontrol and BactoSense of the unchlorinated drinking water of a groundwater production location. Numbers indicate when dynamics can be explained by operational changes in the production location.

Discussion and impact

- Drinking water complied with legal microbiological water quality parameters, still small peaks in cell counts or enzymatic activities were observed with the sensors.
- Interpretation was challenging for water utilities. Often the causes for the variation in the sensor parameters, and their meaning for drinking water quality, remained unclear. Alarm or signal values are thus needed.
- It should be considered for each application if the sensors should be used for continuous monitoring (e.g. a production location) or as a research tool (to better understand a specific treatment step).

Conclusion

- In laboratory dilution series, statistical correlation was strong between BactoSense and laboratory parameters, but was limited for the BACTc except for one location.
- Both sensors identify peaks and aberrations in cell counts or enzyme activity in drinking water that might be missed with routine drinking water monitoring. BACTcontrol
- The BactoSense, and to a lesser extend the BACTcontrol, can be reliably applied to monitor drinking water at high frequencies.

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