An ATP-based method For Monitoring the microbiological quality of the water distribution systems - the challenges and possibilities of the new method

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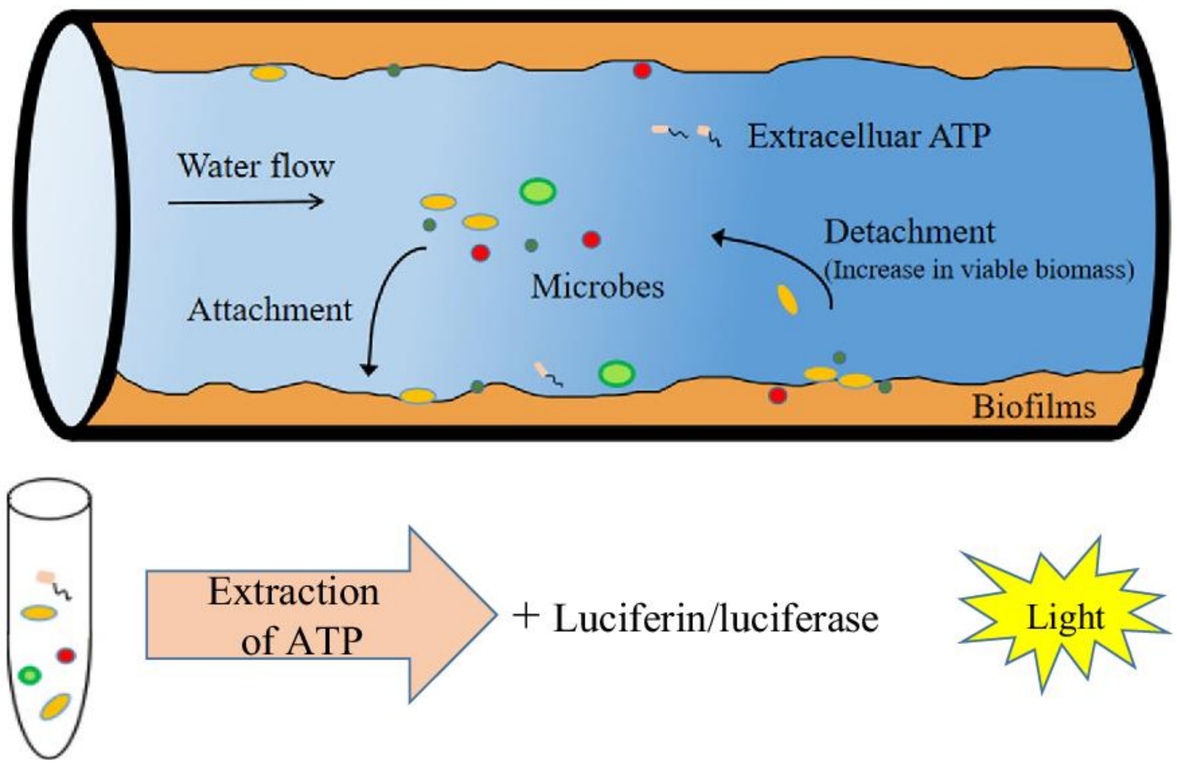
Introduction

The safety of drinking water is a major concern worldwide. The biggest cause of dangerous contamination arises from the deterioration of the microbiological quality of water. At present, the quality is monitored by culture-based methods, which takes several days to obtain a result and not all microbes from the water can be cultured. For this reason, new, fast methods are needed, such as a luminescence-based adenosine triphosphate (ATP) assay.

The ATP assay is an accurate, rapid method with low detection limits. However, the introduction of the ATP assay as part of water quality control requires a comprehensive picture of network-wide ATP concentrations. In addition, factors affecting ATP levels in the distribution systems are not yet fully understood.

This study examined the functionality of the ATP assay as a quality control tool. To do so, information on the ATP concentrations and the factors affecting them from the Turku water distribution system was collected.



Picture 1. Schematic diagram of ATP in a drinking water distribution system and the principle of ATP measurement (Zhang et al 2019).

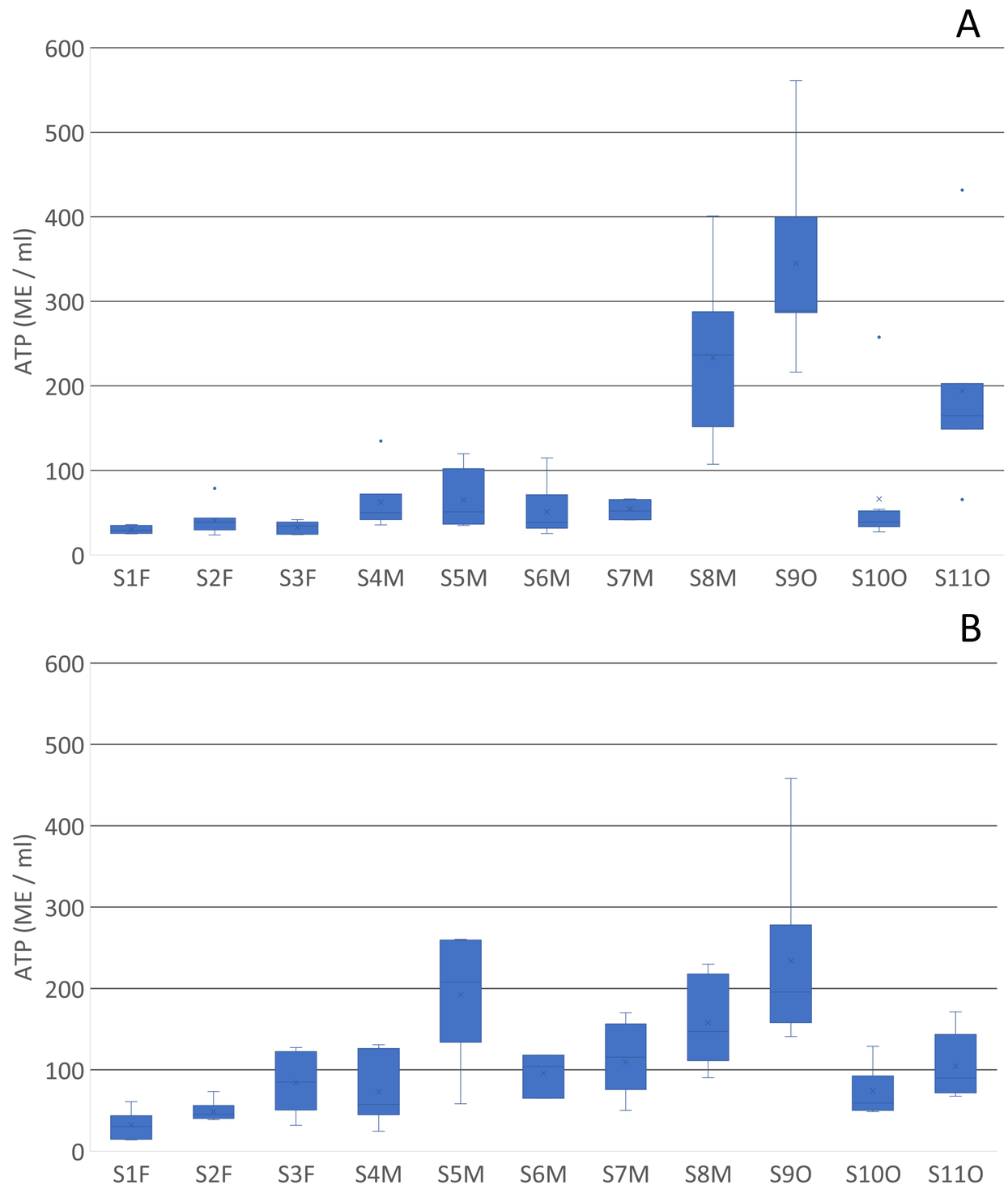
Materials and methods

ATP concentrations from the distribution water network

Two campaigns were carried out on two different summers. Due to seasonal variation, water is of the lowest quality during the summer season in an otherwise stable network environment. 10 Sampling sites were selected from the network based on flow modeling. To study the factors affecting the microbiological quality of the drinking water temperature and chlorine was also measured. Based on the water retention times sampling points were divided into fresher, slightly older, or older water.

The ATP concentrations were measured using commercial kit and a luminometer. ATP was extracted from the sample in the field and the enzyme reaction with luminometer was done in the laboratory. There is a linear relationship between the quantity of light emitted from the reaction and the quantity of ATP present in the sample.

Results and Conclusions



Picture 2. Distribution of ATP concentration from each sampling point during the first (A) and the second campaign (B). S1-S10 indicates the sampling point, letter F stands for Fresh, M for medium, and O for old water. Unit ME means Microbial Equivalent which is based on 1 E. coli-sized bacteria that contains 0.001 pg of ATP

The ATP concentrations from the same sampling point stay relatively stable. The scatter of the results from the second campaign might be caused by the concentrations of chlorine derivatives in the water which are lower than in the previous campaign.

Table 1. Averages of ATP, chlorine derivatives, and temperatures divided by based on the retention times fresh, medium, and old water samples. C1 means the first campaign and C2 means the second campaign.

	C1	C2	C1	C2	C1	C2
	Fresh		Medium		Old	
ATP (Me / ml)	34,8	53,97	89,8	126,4	195,7	139,0
Chlorine derivates (mg / l)	0,41	0,34	0,29	0,23	0,24	0,22
Temperature (°C)	11,1	10,4	12,8	12,6	13,9	12,7

The ATP method is non-specific and not as sensitive as the culture-based methods for fecal contamination indicators such as E. coli. But considering the ATP assay's speed and ease, the measurement is a promising method to routine monitoring of the microbiological status of the water.

Zhang, K., Pan, R., Zhang, T., Xu, J., Zhou, X. & Yang, Y. (2019) A novel method: using an adenosine triphosphate (ATP) luminescence-based assay to rapidly assess the biological stability of drinking water. Appl Microbiol Biotechnol 103:4269-4277.