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On-Line Biosensor to Detect Genotoxic Compounds in Surface Water Using a 3D-Printed Microbioreactor

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Extended Abstract

The quality of safe and clean drinking water is becoming more important. Therefore, harmful pollutants in the surface and ground water need to be detected before drinking water is prepared from this. With the current methods, it is not possible to continuously monitor the intake water for the presence of genotoxic compounds (Woutersen, 2013). Therefore, a new monitor system is developed to detect the genotoxic compounds in surface water before this water is used to prepare drinking water. In this study, a biosensor is used to detect genotoxic compounds in water by *recA* controlled expression of the *lux* gene cluster in *Escherichia coli* strain DPD2794. This is done by continuously testing the surface water in a 3D-printed bioreactor with a working volume of 16 mL. Surface water is continuously added to a small chemostat using a ceramic hollow fiber. The ceramic hollow fiber is placed inside the bioreactor and the water with the genotoxic compounds is pushed through the wall of the hollow fiber from the inside by a syringe pump. Organisms and bigger particles flow through the tube. The water which is pushed through the wall of the hollow fiber goes directly into the bacteria culture in the bioreactor. In this way, organisms in the surface water cannot contaminate the bacteria culture. The bacteria culture is continuously pumped from the bioreactor to a 3D-printed flow cell placed in a dark cabin and back to the bioreactor. The presence of genotoxic compounds in water leads to the expression of the *lux* genes and the luminescence is detected with a photomultiplier placed above the flow cell. Currently the biosensor responds to nalidixic acid with a minimum concentration of 1 mg/L and several biological and physical options are investigated to obtain a higher sensitivity. When the concentration of naladixic acid decreases the *lux* genes are not induced anymore the luminescence fades out and the biosensor is ready to register the next event. The bioreactor consists of three 3D-printed parts and the flowcell is printed as a one piece. The 3D-printing is performed with the stereolithography technique (SLA) using the Form 1 (Formlabs Inc., USA) with their optimized transparent resin. The biosensor requires only low and simple maintenance. Replacing fresh medium and discarding the culture waste is required to keep the system running for at least 30 days.

This study showed an improved design of a biosensor for detecting genotoxic compounds using the stereolithography 3D-printing technique and is a useful addition to the current monitoring systems for surface water. By optimizing the flow cell, media composition, light harvesting and/or recA promotor sequence alterations the biosensor has the potential to detect lower concentrations of genotoxic compounds in surface water.

Woutersen, M. (2013). Development And Validation Of An On-Line Water Toxicity Sensor Based On Genetically Modified, Luminescent Bacteria (Doctoral Dissertation).