A Novel and Low-cost Microfluidic-based C. elegans Electrotaxis Assay for Screening of Toxic Chemicals in Water

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Lack of access to drinking water due to anthropogenic hydrosphere pollution is a widespread humanitarian issue facing the global population, particularly those vulnerable due to their geographical location and/or resource-poor setting. Bioaccumulation of toxicants found in water bodies adversely affects human development, function of organs, and overall health. Barriers to current water-screening assays include cost and portability. Accessible, cost-effective, and sensitive techniques for water quality testing are therefore highly desirable. A novel electrotaxis-based method using C. elegans (nematode) as a biosensor to detect chemicals in water was developed. The method involves exposing animals to commonly-found environmental toxicants (metal and non-metal chemicals) known to be detrimental to human health and measuring changes in the nematode behavior using a microfluidic device. The movement of C. elegans was recorded using a custom MATLAB-based software. The responses were quantified through established paradigms of sinusoidal movement and average velocity. Time-series analysis provided visual representation of animals' responses and revealed patterns of movement that correlated with chemical exposure. The data indicated that chemicals had harmful effects on the movement of nematodes as judged by their slower speed and increased rate of thrashing. The findings confirmed that microfluidic-based C. elegans electrotaxis can be employed for chemical testing in water. This developed procedure could cost as little as $1.50 CAD per m3 of water, thereby greatly reducing the cost of toxicant screening. Overall, the assay is a promising and cost-effective way to screen water and can prevent accidental consumption of toxicants.