Process Relationships for Evaluating the Role of Light-induced Inactivation of Coliphages at Selected Beaches and Nearby Tributaries of the Great Lakes

Richard G. Zepp¹, Marirosa Molina¹, Mike Cytterski¹, Gene Whelan¹, Rajbir Parmar¹, Kelvin Wong², Brad Acrey³, and Rania Georgacopoulos³ (¹US EPA, 960 College Station Rd., Athens GA 30605; ²ORISE Research Participant; ³Student Services Authority)

Introduction

The role of sunlight in the inactivation of pathogenic agents is important to assessing the safety of recreational activities in aquatic environments. The interaction of sunlight with water systems is complex and is governed by a number of factors, including water clarity, turbidity, temperature, and the presence of algae and other biota. In this study, we evaluate the influence of sunlight on the inactivation of selected coliphages (such as MS2 and phiX174) and their relevance to the public health risk of enteric viruses. This information is critical for understanding the role of sunlight in controlling the transmission of enteric viruses and for developing effective strategies to protect public health.

Experimental

Samples of water were collected from selected beaches and nearby tributaries of the Great Lakes. The water samples were then exposed to sunlight for varying periods of time. The exposure duration was determined based on the intensity of sunlight and the water clarity. The water samples were analyzed for the presence of coliphages using classical methods such as plaque assays and molecular techniques such as PCR. The results were then compared to the inactivation rates observed in the laboratory.

Results & Discussion

A model that describes the inactivation of coliphages as a function of sunlight exposure was developed. The model takes into account the effects of water turbidity, temperature, and the presence of algae on the inactivation rates. The model was validated using data from multiple beach locations and was found to be highly accurate in predicting the inactivation rates of coliphages.

Conclusions

Our results show that the sunlight can effectively inactivate coliphages and reduce the risk of enteric virus transmission. The model developed in this study can be used to assess the public health risk associated with recreational activities in aquatic environments. Further research is needed to validate the model under different environmental conditions and to develop guidelines for the safe use of aquatic resources.

References


Sherrard, A., A. R. Nekles, J., P. W. Schilling, L. L. M. and K. A. Parker. Inactivation of Viruses in Open Water Unit Process Treatment (EWOP) Treatment units. Water Environmental Research Foundation. Other research studies showed that coliphages are affected by sunlight at different rates, depending on the water temperature and the concentration of algae.

Other recent studies of bacterial and viral photolysis mechanisms are under evaluation.

Figures

Figure 1: Scatter plot of log CFU/mL vs. exposure time (hr) for MS2 and phiX174 in Lake Michigan samples. The results show a strong negative correlation between sunlight exposure and coliphage inactivation.

Figure 2: Model prediction of coliphage inactivation as a function of sunlight exposure. The model accurately predicts the inactivation rates observed in the laboratory.

Figure 3: Model parameters for the inactivation of coliphages in Lake Michigan samples. The model parameters were estimated using a non-linear regression analysis.

Figure 4: Model validation using data from multiple beach locations. The model accurately predicts the inactivation rates observed in the field.

Figure 5: Comparison of predicted and observed inactivation rates for MS2 and phiX174 in Lake Michigan samples. The model shows excellent agreement with the observed data.

Figure 6: Model validation for coliphage inactivation in rivers and tributaries of the Great Lakes. The model accurately predicts the inactivation rates observed in the field.

Figure 7: Model validation for coliphage inactivation in rivers and tributaries of the Great Lakes. The model accurately predicts the inactivation rates observed in the field.