Monitoring Fecal Indicator Bacteria in Shoreline Water and Beach Sand of Lake Michigan

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INTRODUCTION

There is a direct positive correlation between fecal indicator bacteria (FIB) concentration such as Escherichia coli (E. coli) and Enterococci and the occurrence of gastrointestinal illness of human (Wade et al., 2003). Pathogenic microorganisms cannot be directly monitored as they are of different types and prevalent in water with a very low concentration. Indicator bacteria are used as an alternative for disease causing microorganisms to monitor fecal contamination.

Objectives of the study:
- Examine the concentration and interaction of bacteria in beach sand and water
- Analyze the effects of DI water and PBS eluents to enumerate bacteria from beach sand, and
- Evaluate the impact of algae on bacteria count.

METHODS

Data Analysis
- Bacteria enumeration using IDEXX
  - Most Probable Number (MPN) method
  - Using DI water and PBS eluent for bacteria enumeration from beach sand
- Analyzing effects of eluents (DI water and PBS)
- Impact of algal presence on bacteria concentration
- Data analysis model: Analysis of bacteria data from beach sand and water were performed using U.S. EPA CANARY (Hager et al., 2013), Hart et al., 2007, Haston et al., 2013) Event Detection Software (EDS).

RESULTS

Interaction of bacteria in beach sand and water
Data analysis of bacteria concentration was performed using CANARY EDS software for samples collected during 1st July 2013 to 21st August 2013. Table 1 shows the results from CANARY for each type of bacteria in sand sample with different eluents and in water sample. Results indicated that in sand sample, higher number of events were found for the indicator bacteria than in water sample. Table 1: Results of CANARY output (number of detected ‘Events’) for sand and water sample.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Sand sample</th>
<th>Water sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Enterococci</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Effect of eluents
A paired t-test analysis was performed for both bacteria comparing DI water and PBS eluents as shown in Table 2. A hypothesis testing results indicated that for E. coli, the mean of log MPN of DI was greater than PBS, while for Enterococci it was the opposite.

Table 2: Results of Paired t-test analysis for bacteria

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>DI water</th>
<th>PBS</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>1.138</td>
<td>0.125</td>
<td>0.037</td>
<td>0.7117</td>
</tr>
<tr>
<td>Enterococci</td>
<td>0.89</td>
<td>0.86</td>
<td>0.0019</td>
<td>0.9811</td>
</tr>
</tbody>
</table>

Impact of algae on bacteria concentration
Table 4, it appears that the gradually increasing rating scale of algae was positively correlated with bacteria average count. However, there was an exception to that relation for Enterococci count in water sample. Fig 4 also indicates a significant correlation between E. coli and algae level in water and swash zone sample with p-value <0.05, while for Enterococci the correlation was not statistically significant (p-value >0.05).

Table 4: Average bacteria count with different algae level

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Sampling location</th>
<th>Algae level (scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>Water</td>
<td>4 2 1 0 1 2 4 6</td>
</tr>
<tr>
<td>Enterococci</td>
<td>Water</td>
<td>3 1 1 2 3 2 1 0</td>
</tr>
</tbody>
</table>

Fig 4: Pearson correlation analysis between algae level and bacteria count at 0.05 level of significance

CONCLUSION

The study was undertaken to analyze bacteria concentration for developing methods to accurately predict public health outcomes as a result of increasing fecal indicator bacterial contamination.
- Results from the statistical analysis indicated a possibility of establishing a relationship between the results developed using the two eluents i.e., DI water and PBS for Enterococci, the results were less promising due to high variation in ratios of enumerated bacteria between the two methods.
- CANARY may be useful as an early warning system for monitoring beach contamination and may help to identify any abnormal condition.
- This research showed that there were some differences in bacterial counts produced between eluents. The ability to establish a ratio of bacterial counts among eluents would be a convenient tool in order to compare data collected using different eluents.

Literature cited
- Nabila Nafsin* and Jin Li
  - Impact of algae on bacteria concentration
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Acknowledgments

This work was supported by National Science Foundation (Grant number 0933230)