Background

• Unlike municipal water, well water testing is the responsibility of the well owner.¹
• Nearly 42% of NC residents rely on well water.²
• The presence of total coliform bacteria in drinking water correlates with acute gastrointestinal distress.³
• Many at-home tests are available for total coliform bacteria, however they are sold with limited proof of efficacy.
• Immediate goal was to find an affordable, sensitive, and easy-to-use at home E Coli test.
• Long term goal was to incorporate these findings into a sensitive, and easy-to-use testing kit.

Experimental Setup

Figure 1: Test Mechanisms and Price

<table>
<thead>
<tr>
<th>Test</th>
<th>Cost (in $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colisan</td>
<td>2.40</td>
</tr>
<tr>
<td>SafeHome</td>
<td>9.65</td>
</tr>
<tr>
<td>Aquavial</td>
<td>6.27</td>
</tr>
</tbody>
</table>

Figure 2: Gold Standard: Membrane Filtration Apparatus

Figure 2: A membrane filtration apparatus was constructed using a vacuum Erlenmeyer flask connected to a vacuum line. Flame sterilized forceps were used to transfer filter paper to the apparatus and sample water was pulled through via vacuum. Filter paper was then transferred to agar to be stored and counted. Membrane filtration was performed in triplicate and used as gold standard.⁴

Methods

Figure 3: Initial Test Kit Selection Rubric and Scores

Table 1: Determination of Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Test</th>
<th>True Positives</th>
<th>False Negatives</th>
<th>n</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colisan</td>
<td>24</td>
<td>13</td>
<td>37</td>
<td>0.65</td>
</tr>
<tr>
<td>Aquavial</td>
<td>14</td>
<td>22</td>
<td>36</td>
<td>0.39</td>
</tr>
<tr>
<td>Safe Home</td>
<td>19</td>
<td>6</td>
<td>25</td>
<td>0.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>False Positives</th>
<th>True Negatives</th>
<th>n</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colisan</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Aquavial</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Safe Home</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 4: Test Kit Evaluation Process

<table>
<thead>
<tr>
<th>Markers Selected</th>
<th>Conducted and Tests Identified</th>
<th>Tests Evaluated According to Initial Rubric (Fig. 3)</th>
<th>Poor Scoring Tests Eliminated</th>
<th>High Scoring Tests Ordered for Analysis</th>
<th>Matrix Based Evaluation of Selected Tests</th>
<th>Sensitivity and Specificity</th>
<th>Educational Value</th>
<th>Ease of Use Evaluation</th>
<th>Determination of Best Test Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: *Sensitivity refers to the ability of the test to detect true positives. Specificity refers to the ability of the test to detect true negatives.* Ease of use evaluation pending IRB approval.

Results

Figure 3: This figure depicts relative weighting of criteria for determination of initial test kits, with scores for selected tests.

Discussion

• Safe Home had sensitivity of 0.76, while Colisan and Aquavial had sensitivities of 0.65 and 0.39 respectively.
• Sensitivity = [(True Positives)÷(Total Tests)]
• A sensitivity of 0.76 means that out of 100 samples reported to be negative by the test, 76 of those would be true negatives according to the gold standard method used (membrane filtration).
• All test methods had high specificity, with no false positives returned, but low n may have affected this data.

Conclusions

• SafeHome was the most viable option, with the highest sensitivity and reasonable ease of use, though cost was a prohibitive factor.
• Colisan may be recommended for its educational value and low cost, but the test displayed mediocre sensitivity.
• SafeHome and Colisan may be used in combination, however this has high associated cost.
• Aquascan was eliminated for poor performance in sensitivity trial.
• Challenges persist as to the availability of efficacious and affordable at-home testing solutions for E. coli.

Further Research

• Perform further sensitivity testing with larger sample for Safehome and Colisan.
• Assess Ease of Use with a sample group from a representative population.
• Incorporate best test method into a testing kit to be used in high schools, especially those in rural areas with many well owners.
• Coordinate with the Institute for the Environnemental Health to facilitate implementation as a part of those in rural areas or club activities.

References

