Evaluating At-Home E. Coli Testing Solutions to Improve Water Quality Testing in Eastern NC

ECUIPP LAB — Environmentally-Engaged Communities and Undergraduate students Investigating for Public health Protection
UNC WATER INSTITUTE
UNC GILLINGS SCHOOL OF GLOBAL PUBLIC HEALTH

Avery Matthews, Cole Seifert, Timothy Purvis, Michael Fisher, Amanda L. Northcross
UNC Gillings School of Global Public Health, University of North Carolina, Chapel Hill, NC

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, specific, sensitive, and easy-to-use at home E Coli test
- Long term goal was to incorporate these findings into a testing kit that can be used in high schools in rural areas, potentially being implemented into curriculum as both an educational opportunity and assessment of students' water quality.

Experimental Setup

Figure 1: Test Mechanisms and Price

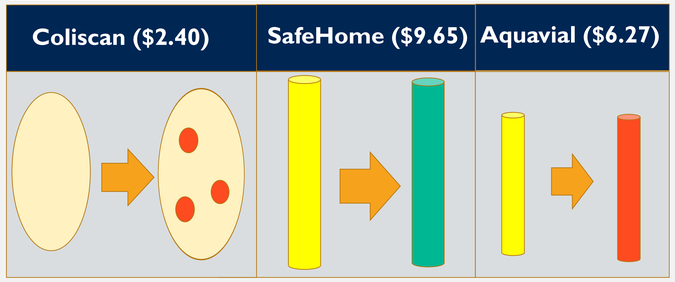

Figure 1: Coliscan test method consists of counting colonies on an agar plate (CFU/100mL). Both SafeHome and Aquavial are color change indicators that change to green and red respectively in the presence of E. Coli.

Figure 2: Gold Standard: Membrane Filtration Apparatus

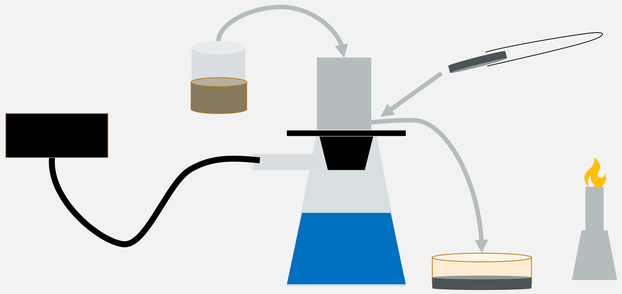

Figure 2: A membrane filtration apparatus was constructed using a vacuum Erlenmeyer flask connected to a vacuum line. Flame sterilized forceps were used to transfer filter paper to the apparatus and sample water was pulled through via vacuum. Filter paper was then transferred to agar to be stored and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

Methods

Figure 3: Initial Test Kit Selection Rubric and Scores

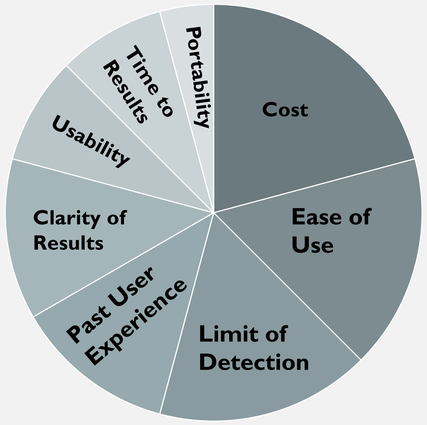

Figure 3: This figure depicts relative weighting of criteria for determination of initial test kits, with scores for selected tests.

Test	High Scores	Low Scores
Coliscan	• Cost • Limit of Detection • Past User Experience	• Time to Results • Ease of Use
Aquavial	• Ease of use • Portability	• Clarity of results • Time to results
Safe Home	• Ease of use • Portability	• Cost • Time to results

Figure 4: Test Kit Evaluation Process

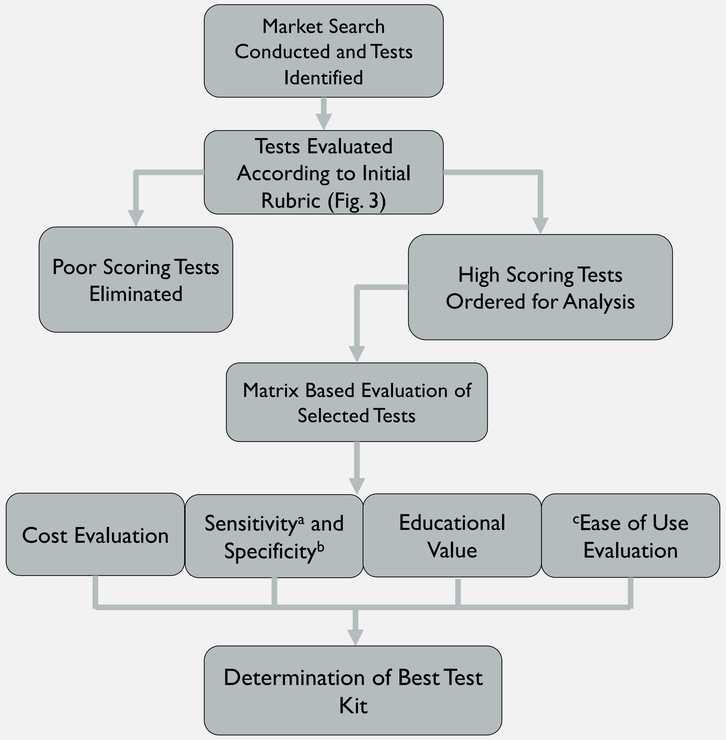

Figure 4: [a]Sensitivity refers to the ability of the test to detect true positives. [b]Specificity refers to the ability of the test to detect true negatives. [c]Ease of use evaluation pending IRB approval.

Results

Table 1: Determination of Sensitivity and Specificity

Test	True Positives	False Negatives	n	Sensitivity
Coliscan	24	13	37	0.65
Aquavial	14	22	36	0.39
Safe Home	19	6	25	0.76
Test	**False Positives**	**True Negatives**	**n**	**Specificity**
Coliscan	0	3	3	1
Aquavial	0	2	2	1
Safe Home	0	3	3	1

Discussion

- Safe Home had sensitivity of 0.76, while Coliscan 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.
- Coliscan may be recommended for its educational value and low cost, but the test displayed mediocre sensitivity.
- SafeHome and Coliscan 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 Coliscan
- 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 Environment to facilitate implementation as a part of curriculum or club activities.

REFERENCES

•1. Protect Your Homes Water. EPA. https://www.epa.gov/privatewells/protect-your-homes-water#welltestanchor. Published 2022. Accessed April 21, 2022.
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