Microbial Quality and Safety of Well Water in Rural Nicaragua as Determined by Low Cost Bacterial Test

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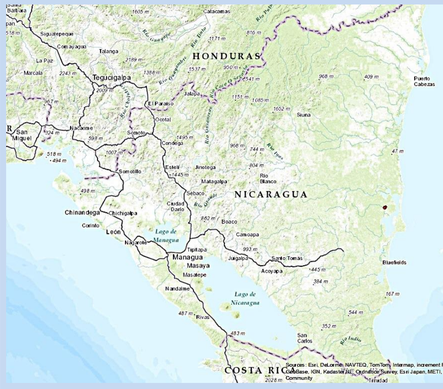
Introduction

In total, 783 million people still lack access to improved drinking water sources. About 2.5 billion people lack access to improved sanitation and some 1.1 billion people practice open defecation. The majority of these people live in rural areas of developing countries. Even with improved access, which is often wells, no water quality testing has been done. Thus, water safety of this rural water supply in developing countries still remains questionable (UNICEF and World Health Organization, 2012).

Indicator bacteria such as *E.coli*, are used to determine the sanitary quality of water and to indicate the possible presence of other disease causing microorganisms in water (Pepper et al., 1996) .

The main objective of this study was to determine the microbial water quality of drinking water from wells in rural Nicaragua using the **Compartment Bag Test (CBT)**. CBT is a low cost *E. coli* detection method, which is developed for low resource settings in order to quantify the sanitary quality of water used for drinking.

Study Location



Samples were collected from a small, rural village called Pueblo Nuevo. The village lies on the east coast of Nicaragua, near the Rio Wawashang Reserve.

Fig. 1. Map of Nicaragua with Pueblo Nuevo circled.

Fig. 2. Types of wells sampled (simple and rope-pump). The wells served a range of 4 to 20 people and 1 to 4 families.

Cases of Illness in Pueblo Nuevo (2012)

Respiratory Infections: 8,750
Water-related Diarrhea: 5,675
Pneumonia: 47
Parasites: 2,850

Methods

Fig. 3. Transportation and incubation of CBT

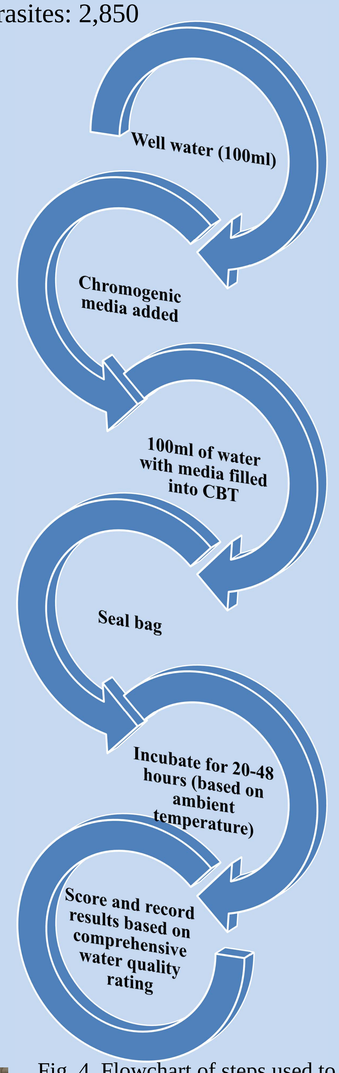


Fig. 4. Flowchart of steps used to prepare CBT

Fig. 5. Membrane filtration on-site

Membrane filtration (1.4 – 1.8 liters of well water) and qPCR

E. coli, enterococci
Microbial source tracking markers:
Bacteroides thetaiotaomicron (human), M2 (bovine)

References

Pepper, I. L., Gerba, C. P., & Brusseau, M. L. (1996). Pollution science. San Diego, CA: Academic Press.

UNICEF and World Health Organization. (2012). Progress on Drinking Water and Sanitation 2012. Retrieved from http://www.unicef.org/media/files/JMPreport2012.pdf

Results

- 32 wells total
- 87.5% of wells contaminated with *E. coli*
- Contamination ranged from 5.5 - 404.5 MPN/100 ml (Geometric mean 22/100 ml)

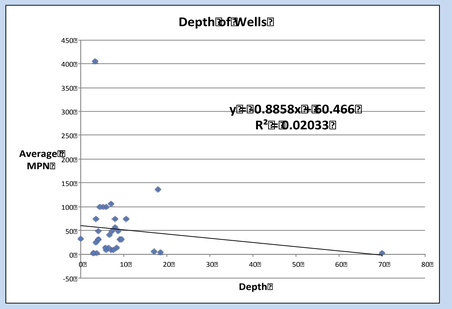


Fig. 6. The average MPN of samples relative to depth of wells

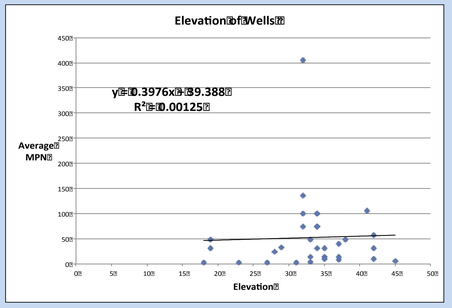


Fig. 7. The average MPN of samples relative to elevation of wells

Comparison of *E. coli* MPN between simple and rope-pump wells

The geometric mean for simple and rope-pump wells was found to be 34.37 and 12.34 MPN/100ml respectively. This shows 64.1% reduction in *E. coli* from simple wells to rope-pump wells (a log-transformed t-test, t value = -2.11 and p value = 0.02).

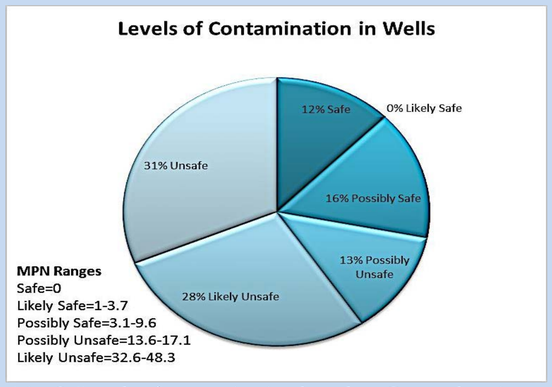


Fig. 8. Levels of contamination based on Comprehensive Water Quality Rating

Table 1. qPCR detection of molecular markers (No. sample tested: 31)

qPCR assay	No. sample positive	Average concentration (copies/100ml)
E. coli	5	5.5×10^4
Enterococci	6	1.1×10^2
M2 marker (bovine)	4	4.3×10^2
B. theta marker (human)	0	-

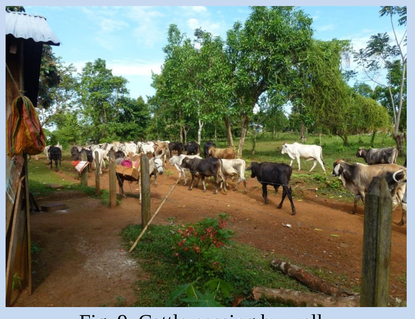


Fig. 9. Cattle passing by well

Conclusions

- Generally the well water was deemed unsafe in this small rural area in Nicaragua.
- The CBT made it possible to test in the field for *E.coli* contamination in a rural location where supplies and lab equipment was limited.
- qPCR analysis indicated bovine fecal pollution in the well water samples.

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