Assessing the Stability of Food Safety Relevant Soil Samples: A Survival Study Across Sampling Methodologies

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micro-CCS
Microbial Interactions Create Research Opportunities for Community College Students

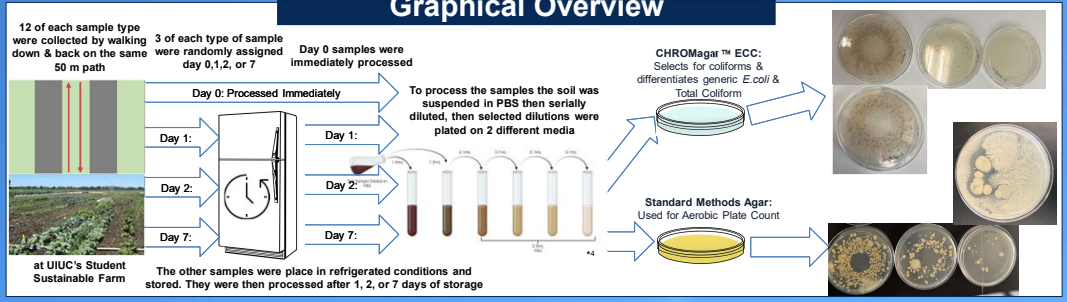
PARKLAND COLLEGE | UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Objectives

Big Picture:
Develop an effective & scalable soil sampling method optimized for screening a variety of preharvest agricultural fields to improve produce safety.

This Project:
- Assess the stability of aggregative soil samples when stored under refrigerated conditions (30°F/1.11°C).
- Determine if the stability of the collected samples is impacted by sample type and/or wetting agent used.

Graphical Overview



Findings

- Replicates varied within +/- 1 Log10(CFU/g).
- Initial Log10s APC were similar for all sample types, however for Gen *E.coli* & Total Coliforms soil grabs showed lower recoveries than boot covers & drag swabs.
- Differences in Log10(CFU/g) values for all 3 indicators were not biologically significant across all sample types between days 0,1, & 2, as well as day 7 for Total Coliforms.
- For the samples processed on day 7 however there was some reduction seen in Gen *E.coli* but was still present.
- For APC Boots & Drags had showed ~1 Log10 increase on day 7 & the BPW samples had > increase than PBS

Research Context

Foodborne Illness & Produce:
- A review of data from 1998 – 2008 attributed 46% of foodborne illness to produce.*[1]
- The CDC's 2023 foodborne illness report found over 80% of *Escherichia coli* O157 & ~21.5% of *Listeria monocytogenes* cases came from vegetable row crops.*[2]
- Improved environmental sampling has helped reduce risk in the meat industry but has yet to be done for agriculture.

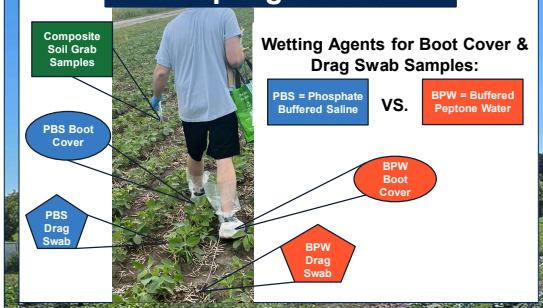
Previous Research: showed that soil samples collected w/ boot cover swabs (standard in meat processing) detect food safety relevant indicator organisms ≈ to soil grabs*[3]

Why Sample Soil Preharvest?
- Soil is reservoir for and a vector by which foodborne pathogens can spread.

- In commercial agriculture, eliminating all environmental avenues for pathogens to reach the soil is nearly impossible, as is testing every plant or the harvest tools in between each one.
- **Instead:** Target the risk (soil in preharvest fields)

Why is Sample Stability Important?
- In current research all samples are processed within 24 hours of collection, but commercial growers can't.
- During transit &/or processing delays the samples are stored under refrigerated conditions, but what does that mean for the accuracy & relevance of the information collected?

Sampling Methods



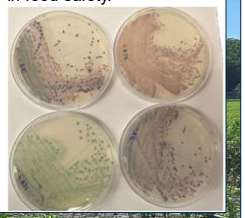
Wetting Agents for Boot Cover & Drag Swab Samples:

PBS = Phosphate Buffered Saline **VS.** BPW = Buffered Peptone Water

Indicator Organisms

Aerobic Plate Count (APC):
- Indicator for total microbial load in a sample (also called standard plate count) used widely in food safety.

Total Coliforms
&
Generic *E.coli*
- Both are used to indicate possible fecal contamination.



What's Next?

To make conclusions about the trends seen in this study:
- A larger sample size (>n=30) w/ additional locations may be preformed.

Continuing to collect soil samples at different time points & conditions will provide insight into:
- The seasonality of the soil microbiome
- What environmental conditions and/or weather events will impact soil microbiology & recovery levels of the sampling methods and how.
- How variation in what is being grown on a field will impact the taxonomic profile of the soil & relevant microbes.

We know that drag swabs & boot covers can recover food safety indicator organisms, but for a more complete picture of exactly is being recovered:
- DNA extraction is being preformed on the collected soil samples which when sequenced will give a much more exact picture of the soil taxonomy of our sampling sites.
- Exploring if and what other methods of assessing soil microbiology (like various culture independent techniques) can provide relevant information for food safety.
- There is also the potential to begin testing for the presence of more specific foodborne pathogens

To ascertain and explore the impact of the soil composition and how that can impact the efficacy and recovery of the different sampling methods:
- A collaboration with a soil focused lab at the University of Illinois at Urbana-Champaign is currently in progress.

Results

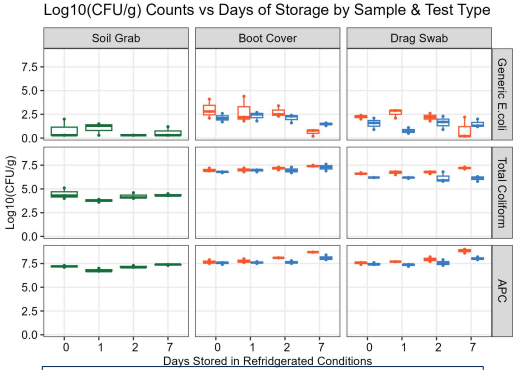


Figure 1: The above boxplots show the Log10(CFU/g) count of each food safety indicator organism measured during this experiment (Generic *E.coli*, Total Coliforms, & the Aerobic Plate Count (APCs)) for all sample types by the number of days after collection that the sample was stored in refrigerated conditions before being processed.

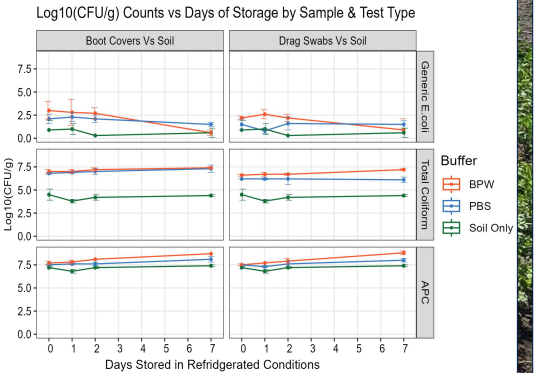


Figure 2: The above line graphs show the average Log10(CFU/g) count for the three replicates of all sample types as a function of the number of days after collection the samples were stored in refrigerated conditions before being processed. Error bars shown represent +/- 1 standard deviation.

References:

*[1] Painter, J. A., Hoekstra, R. M., Ayers, T., Tauxe, R. V., Braden, C. R., Angulo, F. J, & Griffin, P. M. (2013). Attribution of Foodborne Illnesses, Hospitalizations, and Deaths to Food Commodities by using Outbreak Data, United States, 1998–2008. Emerging Infectious Diseases, 19(3), 407-415. https://doi.org/10.3201/eid1903.111866.
*[2] Interagency Food Safety Analytics Collaboration. Foodborne illness source attribution estimates for *2021* for *Salmonella*, *Escherichia coli* O157, and *Listeria monocytogenes* using multi-year outbreak surveillance data, United States. Atlanta, Georgia and Washington, District of Columbia: U.S. Department of Health and Human Services, CDC, FDA, USDA/FSIS. *2023.*
*[3] Wu, J., Gathman, R. J., Portillo, R. J., Gaulke, C., Kim, M., Stasiewicz, M. J. (2023). Aggregative Soil Sampling Using Boot Covers Compared to Soil Grabs From Commercial Romaine Fields Shows Similar Indicator Organism and Microbial Community Recoveries, Journal of Food Protection, 86 (11), https://doi.org/10.1016/j.jfp.2023.100177
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More Info?

Stasiewicz Food Safety Lab website:

Questions for Me? Reach out here: