

Survey of Agricultural Water Microbial Quality in Kansas and Missouri

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Introduction

In the United States, consumption of fresh fruits and vegetables has increased (1,2). Produce production requires significant pre- and post-harvest input of agricultural water (3), an established vector of foodborne illness bacteria (4). The Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) aims to prevent on-farm contamination of fresh fruits and vegetables thus reducing foodborne illness, providing produce growers with safety standards in the areas of wildlife management, biological soil amendments, and agricultural water.

The PSR requires fresh produce growers to test agricultural water and develop a microbial water quality profile (MWQP) of water sources used for production and postharvest. These requirements represent a significant investment of time and resources for growers. Research and extension efforts that alleviate this burden ensure PSR compliance and strengthen produce safety nationwide.

Objective

To determine the prevalence of generic *Escherichia coli* in agricultural water sources.

Materials and Methods

A 100 mL sample was taken by growers or Extension personnel from agricultural water sources at approx. 200 produce farms located in Missouri and Kansas (N = 679). For surface water sources, a sampling stick with bottle attached (Figure 1) was dipped down below the surface 6-12 inches and ≥ 10 feet from the water's edge to prevent collection of sediment and algae. For well water sources, the pump was run for ≥ 1 minute, ensuring a representative sample was collected. Following collection, sample bottles were placed in a sealable plastic bag, set on ice, and shipped to the water testing laboratory. Care was taken to ship samples within 24 hours of collection and temperatures did not exceed 10°C throughout shipping.



Figure 1: Sampling procedure for surface water source. 1) sample bottle fastened to pool stick, dipped in 6-12 inches below surface and ≥ 10 feet from the water's edge, 2) sample bottle capped and placed in a sealable bag on ice for shipment to laboratory.

Upon arrival, Colilert reagent (IDEXX Laboratories, Westbrook, ME) was added to the sample bottle, shaken until dissolved, poured into a Quanti-Tray/2000, sealed using an IDEXX Quanti-Tray Sealer, and incubated at $35 \pm 0.5^\circ\text{C}$ for 24 hours. When Colilert nutrient-indicator ONPG was metabolized by coliform bacteria, sample wells turned yellow. When generic *E. coli* metabolized Colilert nutrient indicator MUG, the sample well fluoresced (Figure 2). Well color or fluorescence was read using a Most Probable Number (MPN) table. Generic *E. coli* results were reported as MPN/100mL to grower.

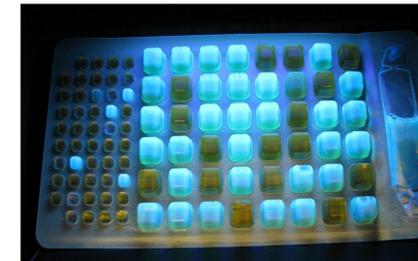
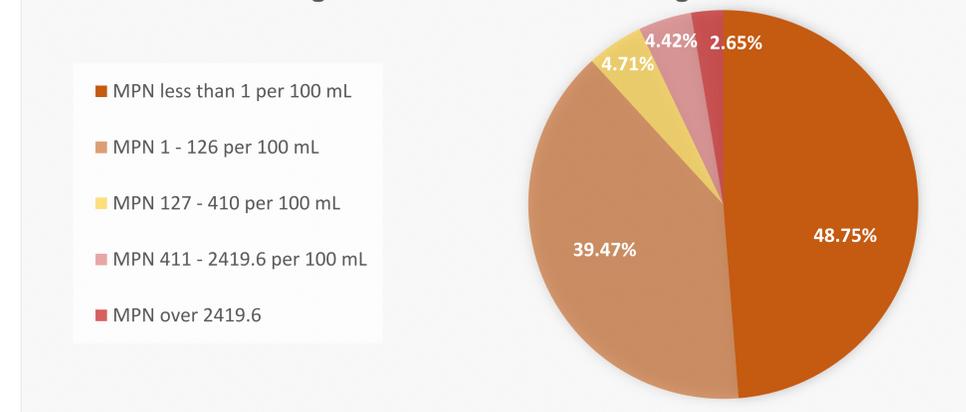


Figure 2: Colilert Quanti-Tray/2000 following 24-hour incubation at $35 \pm 0.5^\circ\text{C}$. Fluorescent wells represent positive generic *E. coli* while yellow wells indicate positive total coliforms.

Results

Prevalence of generic *Escherichia coli* in agricultural water



* MPN means Most Probable Number

Figure 3: Generic *E. coli* prevalence data (N=679) for all surface, ground, and other agricultural water sources.

Table 1: Generic *E. coli* prevalence data in ground and surface water sources.

MPN/ 100mL	Ground Water		Surface Water	
	n=278	percent	n=382	percent
Less than 1	219	78.8%	98	25.7%
1 - 126	48	17.3%	215	56.3%
127 - 410	5	1.8%	27	7.1%
411 - 2419.6	1	0.4%	29	7.6%
> 2419.6	5	1.8%	13	3.4%

Discussion

As per the FSMA PSR guidelines, the generic *E. coli* population in an agricultural water source used pre-harvest must not exceed a geometric mean (GM) of 126 CFU/100 mL and standard threshold value (STV) of 410 CFU/100 mL. Eighty samples (N=679, 11.78%) exceeded the GM, while 48 samples (7.06%) surpassed the STV. Eighteen (2.65%) samples exceeded 2419.6 CFU/100 mL, the maximum reportable value of the Colilert test. A total of 18.06% and 3.96% surface and ground water samples were above the GM limit of 126 CFU/100 mL. As per the FSMA PSR, for post-harvest use, agricultural water must have 0 generic *E. coli* in 100 mL water sample. In all our ground water samples, 78.8% have less than 1 MPN generic *E. coli* /100 mL water, making these water sources suitable for post harvest use by meeting the FSMA PSR criteria for post harvest water quality standards.

Conclusion

Water plays a crucial food safety role in the production of fresh fruits and vegetables. Numerous direct points of contact between water and food from farm to fork make it a potential source of contamination and a food safety concern. Microbial surveillance of agricultural water in Kansas and Missouri indicated that the majority (88.22%) of sampled agricultural water did not exceed the FSMA PSR generic *E. coli* GM guideline (126 CFU/100 mL) for pre-harvest water. For contaminated samples (generic *E. coli* > 126 CFU/100 mL), several corrective measures can be implemented to reduce the contamination and meet the PSR numerical criteria for water. Routine surveillance of water quality used for production of fresh fruits and vegetables is critical to ensure the safety of fresh produce. Knowing the water quality through long-term testing will help establish management practices for appropriate use of the water.

Selected References

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Disclaimer: Colilert testing results were reported as MPN/100 mL while FSMA PSR guidelines indicate limits based on CFU/100 mL. For the purposes of this regulation, MPN and CFU are considered to be synonymous.