Virginia Cooperative Extension
Virginia Tech • Virginia State University

Publication FST-348P

Microbial Quality of Water Used in Potato Packinghouse Operations

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Background

Postharvest handling of potatoes on the Eastern Shore of Virginia (ESV) regularly includes the use of flumes, dump tanks, and spray washers. Water used in flumes and dump tanks is often re-circulated to conserve water and energy. Soil, plant matter, and disease-causing pathogens can potentially accumulate in water during bin dumping and flume recirculation.

Contaminated water used in flumes and dump tanks may transmit diseases that decay the potato and adversely affect human health. Sanitizers, such as chlorine or peracetic acid, may be used to manage risks associated with postharvest water (e.g., cross contamination).

Not much published research exists on the microbial quality of water used in postharvest handling of potatoes. The lack of data on postharvest water in potato operations is largely a result of potatoes being classified as a low-risk agricultural commodity for food safety, as they are typically not consumed raw. However, with the implementation of the Food Safety Modernization Act (FSMA), several Good Agricultural Practices (GAP) audit schemes are aligning with the FSMA Produce Safety Rule. For covered produce, the FSMA Produce Safety Rule requires that water used during harvest or postharvest activities have zero detectable generic *E. coli*, and it does not allow the use of untreated surface water during harvest or postharvest activities (FDA 2015). While potatoes are not a covered crop under the FSMA Produce Safety Rule, GAP requirements do not differentiate between covered and non-covered crops (USDA 2011). Thus, concerns about the water quality used during potato postharvest handling activities — for example, the use of untreated surface water — has come under scrutiny.

This project evaluated the microbial quality of water used in potato packinghouse operations using generic *E. coli* as a indicator. It is important to note that generic *E. coli* is not a human pathogen, but is used as an indicator of microbial contamination. Ultimately, this data will be useful to potato packers and rule-makers in determining best practices for potato postharvest handling.

Methods

Study Design. Five potato packinghouse operations were sampled three times each during the 2015 season. At each visit, water and potato samples were collected in triplicate during two time points (in the morning, between 8 a.m. and 11 a.m., and in the afternoon, between noon and 3 p.m.) at each relevant location in the packinghouse (figure 1). A total of 630 samples were collected.

Potato packinghouses were enrolled in the study based on willingness to participate. Information was collected on potato packinghouse handling, including source of water and type of sanitizer, among other information.

Sample Collection. Water samples were collected in sterile 1 liter bottles from flumes used to wash initial organic material (e.g., dirt, debris) off potatoes (n=90), and from spray bars used to rinse potatoes before they are dried and packed (n=90). Potato (whole) samples were collected from incoming bulk bodies/before entry into flumes (n=90); flumes (n=90); post-flume/before spray bar (n=90); spray bar/during spraying (n=90); and post-spray bar/after drying/before packing (n=90) (figure 1). All water and potato samples were transported back to the laboratory on ice and processed within three hours (same day).

Produced by Virginia Cooperative Extension, Virginia Tech, 2019

VT/1019/FST-348P

Sample Processing. Samples were tested for generic *E. coli* using the Most Probable Number (MPN) method with the IDEXX Colilert-18 test and Quanti-Tray/2000 system (standard method 9223B). This method quantifies the amount of generic *E. coli* in 100 milliliters of water.

For water samples, 100 milliliters of water was distributed into sterile bottles and processed using the IDEXX Colilert-18 and Quanti-Tray/2000 standard protocol (available at https://www.idexx.com/en/water/water-products-services/colilert-18/ and https://www.idexx.com/files/quanti-tray-2000-procedure-en.pdf).

For potato samples, each whole potato was added to 100 milliliters of sterile water in a sterile whirl-pak bag and hand massaged for five minutes, alternating rubbing and shaking in 30-second intervals. The whole potato was aseptically removed from the bag and discarded, with the remaining 100 milliliters of water transferred to a sterile bottle and processed as a water sample described above. Laboratory studies demonstrated this method was adequate to quantify generic *E. coli* from a potato.

Statistics. All data were analyzed using JMP Pro 13 statistical software (SAS Institute Inc., Cary, North Carolina). An analysis of variance and Tukey's multiple comparison test was performed to determine differences between mean values of sampling locations (shown in figure 1). Additionally, a t-test was used to determine differences between sampling visit (three times during the packing season) and time-point (morning or afternoon) mean values. Differences were considered significant at $P \leq 0.05$.

Results and Discussion

No significant difference was observed in generic *E. coli* populations between the two time points sampled (morning and afternoon) for water or potato samples. Additionally, no significant difference was observed in generic *E. coli* populations between any of the three sample collection visits. As a result, all data was combined for further analysis.

Information on Potato Packinghouses. Potatoes are grown under the soil and dug up during harvest; thus, all potato packinghouses used a flume to wash off high loads of organic material from potatoes before further handling. For all packinghouses, the source used for the flume water was a retention pond filled by well water or rainwater. Retention ponds were used because wells alone could not recharge with water fast enough for direct use, and the volume of water needed to wash off organic material was high. To follow best practices for water quality outlined by the National Potato Council (2015), all potato packinghouses applied a final rinse with water that meets U.S. Environmental Protection Agency's microbial standards for potable water. This final rinse in all potato packinghouses was

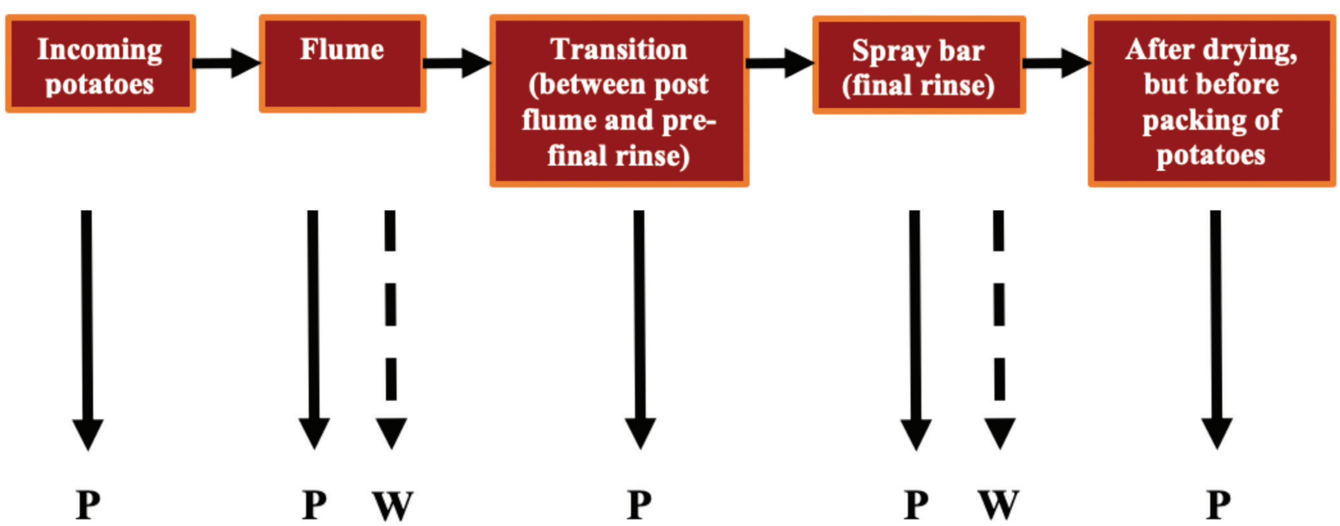

Figure 1: Sample collection points in a potato packinghouse. Researchers collected water (labeled as W) and potato (labeled as P) samples at each step shown in the diagram. A total of 630 samples were collected; n=90 at each P and W location. For example, flume water samples were collected in triplicate at two time points for each of the five packinghouses at three times during the potato packing season in 2015, resulting in a total of 90 flume water samples.

applied using a spray bar system before drying and packing of potatoes. Additionally, three of the five packinghouses added a sanitizer to the final rinse water (two used chlorine-based sanitizers, and one used a peracetic acid-based sanitizer) to assist in maintaining the water quality throughout the operational run, as well as to prevent potential biofilm buildup from any residual organic material.

Water. The average population of generic *E. coli* in flume water samples (n=90) was 413 MPN/100 milliliters, while the average population of generic *E. coli* in spray bar water (n=90) was below the limit of detection (<1 MPN/100 milliliters or zero detectable generic *E. coli*). In fact, all water samples tested from the spray bars had zero detectable levels of generic *E. coli*. Generic *E. coli* populations were significantly higher in flume water compared with spray bar water. This was expected, as water was sourced from retention ponds (surface water) for flumes and wells (ground water) for spray bars. It is possible that surface water exposed to the open environment may be positive for generic *E. coli* due to proximity to surrounding landscape features and/or because of weather events, such as extreme rainfall (Truitt et al. 2018).

Potatoes. The average population of generic *E. coli* on potato samples from incoming bulk bodies/before entry into flumes, in flumes, post-flume/before spray bar, spray bar, and post-spray bar/before packing was 106, 386, 251, 3 and less than 1 MPN/100 milliliters, respectively (figure 2). Populations of generic *E. coli* on potatoes were significantly higher on incoming potatoes, potatoes from the flume, and potatoes post-flume, compared with potatoes from the spray bar and potatoes post-spray bar/after drying/before packing. Potatoes were visibly cleaner by the time they reached the spray bar final rinse. The water used for the final rinse in the spray bar system was effective at reducing the quantity of generic *E. coli* on potatoes, as generic *E. coli* populations were below the limit of detection for all potato samples tested post-spray bar/after drying/before packing (figure 2).

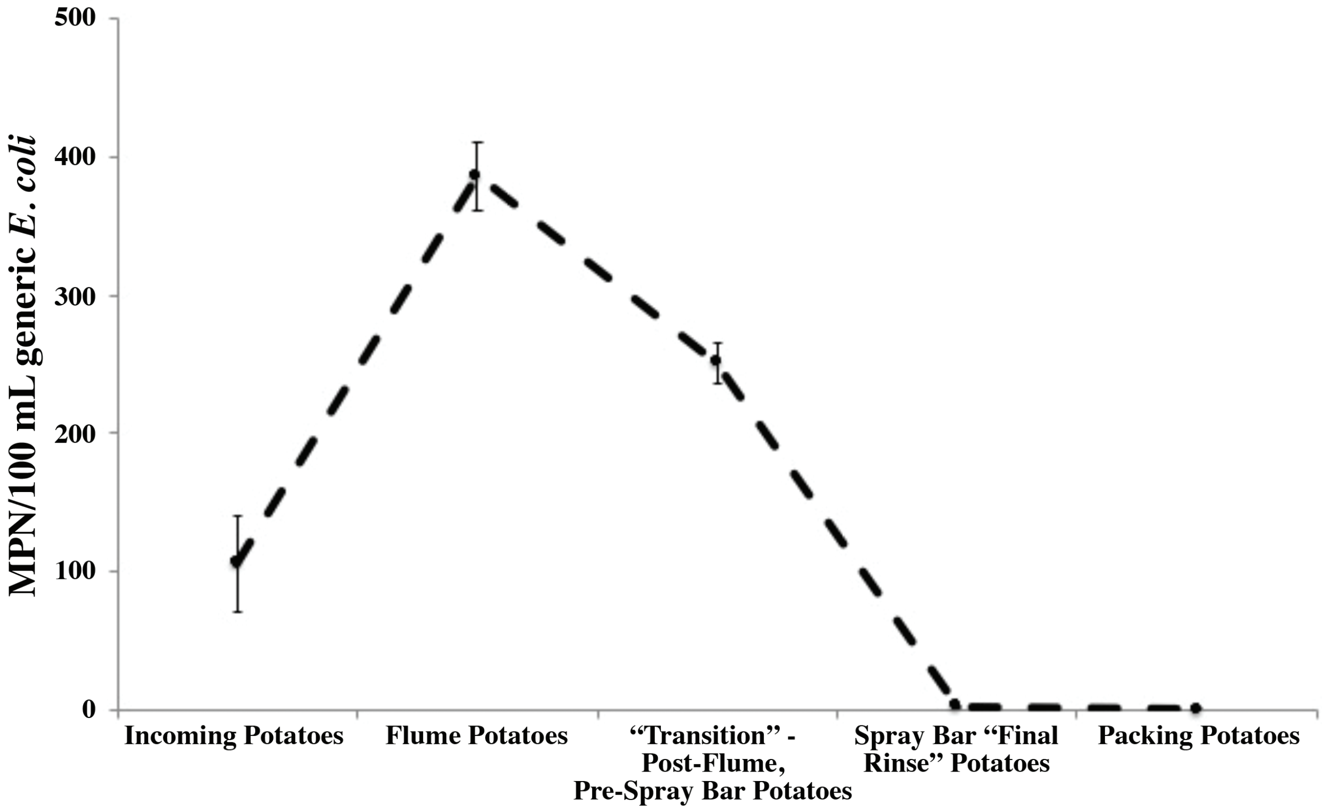

Figure 2: Average generic *E. coli* (MPN/100 milliliters) population with standard deviation in potato samples from incoming bulk bodies/before entry into flumes, flumes, post-flume/before spray bar, spray bar, and post-spray bar/before packing (n=90 each).

Conclusions

Currently, the National Potato Council's *Commodity-Specific Food Safety Guidance for the Production, Harvest, Storage, and Packing of Potatoes* states "if water is used to flume and wash potatoes that are destined for fresh market, a final rinse with water that meets the U.S. EPA's microbial standards for potable water should be applied to potatoes." Our data show populations of generic *E. coli* on potato samples are significantly lower after the final rinse compared with before the final rinse. Therefore, our findings support the National Potato Council's best management practice regarding a final rinse.

References

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