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Knowledge and Current Practices Related to Agricultural Water Microbial Quality among Kansas and Missouri Produce Growers

ABSTRACT

Kansas State University and University of Missouri Extension educators have been providing training and information on agricultural water microbial quality to help produce growers reduce risk. However, we recognized the need to determine knowledge gaps among Kansas and Missouri growers related to agricultural water quality and best practices. A survey was developed to determine future extension outputs and activities to encourage growers to improve their practices related to water quality. The survey was distributed to Kansas and Missouri produce growers attending in-person or online produce-related events in late 2020 and early 2021 and was also distributed through email lists of produce growers from both states. Survey results (n = 101) indicate that 13.9% of the respondents tested their water for generic *Escherichia coli* more than once a year, whereas 38.6% of the participants had never tested their water. Approximately half (59.3%) of respondents indicated they used municipal water for postharvest uses, whereas 6.7% indicated the use of untreated surface water for postharvest activities. To address potential water contamination risks, researchers suggest that further training and educational resources would help growers improve practices related to water quality and produce safety.

INTRODUCTION

In recent years, foodborne disease outbreaks resulting from fresh produce have continued to occur *(4, 12)*. Because these commodities are often consumed raw *(26, 28)*, it is imperative that fresh produce growers use the safest practices possible. From 2010 to 2017, a total of 85 multistate outbreaks associated with fresh produce with confirmed etiologies occurred in the United States, resulting in a known combined total of 4,658 known illnesses, 1,187 hospitalizations, and 55 deaths *(4)*. Further, before 2015, numerous fresh produce outbreaks have been attributed to contaminated agricultural water in commodities such as leafy greens *(15, 22)*, tomatoes *(2)*, and melons *(33)*. Thus, water quality management practices became a major and critical aspect of the U.S. Food and Drug Administration's (FDA) Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR) *(31)*.

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The PSR was finalized in 2015, to take its place as one of the seven foundational rules under FSMA; it is the first U.S. federal regulation to have established science-based minimum standards for the safe growing, harvesting, packing, and holding of fruits and vegetables grown for human consumption. In December 2021, the FDA proposed a revision to Subpart E of the PSR that would change the preharvest agricultural water requirements for covered produce, other than sprouts *(32)*. The FSMA PSR and the proposed revision state the considerations and requirements related to agricultural water management to improve the microbial safety of agricultural water and, therefore, of produce. In December 2021, FDA announced their intent to exercise enforcement discretion and also act to extend the compliance date for the agricultural water *(31)*.

As per the FSMA PSR, "agricultural water means water used in covered activities on covered produce where water is intended to, or is likely to, contact covered produce or food contact surfaces." Agricultural water is classified into two categories based on the different usage periods: production water and postharvest water. Production water refers to water used during growing activities, whereas postharvest water includes all uses of water during or after harvest *(7, 31)*. Because the use of postharvest water occurs so close to consumption, microbial water quality is especially important *(6)*. Thus, produce growers must meet the requirements of §112.44(a), i.e., no detectable generic *E. coli* per 100-mL water sample for water used postharvest. The proposed revisions to Subpart E focus on production (i.e., preharvest) uses of agricultural water. These revisions emphasize conducting agricultural water assessments for production water sources and uses, eliminating the federal requirement of an ongoing microbial water quality profile with periodic updates through water quality monitoring.

Each year, Kansas and Missouri growers produce approximately $26 million *(13)* and $81 million *(7)*, respectively, of fruits and vegetables. Kansas State University and University of Missouri Extension educators have been providing training and information on agricultural water microbial quality, based on current and newly proposed FSMA PSR agricultural water requirements, to help produce growers from Kansas and Missouri reduce risk to produce from agricultural water. Although research shows that knowledge gain alone leads to limited behavior change, it can provide people with more informed choices that may or may not lead to behavior change *(16)*. Pratt and Bowman *(21)* suggest that individually relevant, problem-focused, and hands-on activities can help extension educators prompt personal behavior change. To help prompt this positive behavior change, educators need a better understanding of the gap between water quality best practices and produce growers' knowledge and actions related to agricultural microbial water quality.

Survey research *(20)* is one method that allows extension educators to easily understand a large number of growers' current water practices and knowledge gaps in a relatively short time. Surveys have previously been conducted to assess growers' general produce safety knowledge *(18, 19)* and needs *(17)* to help them to comply with produce safety best practices. Perry et al. *(18)* found that North Central U.S. produce growers have a knowledge gap in understanding agricultural water handling practices compared with other topics of the FSMA PSR, which highlights the need for food safety extension educators to focus on delivering information on agricultural water best practices to produce growers.

This survey aims to determine gaps between safe water management practices (as outlined in the FSMA PSR requirements and proposed requirements and other produce safety best practices) and (i) the current knowledge and (ii) the current practices of produce growers from Kansas and Missouri related to agricultural water quality. Based on this knowledge, extension educators will be able to develop additional training and resources on agricultural microbial water quality to better meet the needs of growers.

MATERIALS AND METHODS

The project team developed a 14-question survey instrument based on similar surveys *(17)*. Before implementing the survey, four extension experts reviewed the survey questions for face and content validity. The Kansas State University Produce Safety Extension Associate also performed cognitive interviews *(14)* with growers from the target population to further validate the survey. The Kansas State University Human Research Institutional Review Board approved the use of the survey. The survey *(Appendix 1)* included questions on the growers' knowledge and practices related to microbial water quality and was administered from October 2020 to August 2021. Due to in-person meeting restrictions related to the COVID-19 pandemic, produce growers mainly completed the survey online in Qualtrics software (Qualtrics XM, Seattle, WA) ($n = 76$) during online produce safety-related trainings or by distribution of the online survey link to email listservs of produce growers in Kansas and Missouri. Other respondents ($n = 30$) completed paper copies of the survey during an in-person horticulture farm field day or in-person produce safety training sessions. Two drawings for gift cards were utilized to incentivize participation in the survey both online and in-person. To optimize data collection, potential survey respondents were asked to complete the survey only if they were able to answer questions related to their operations' water management practices. Because most produce farms in Kansas and Missouri have only a few people working on them *(29, 30)*, we are confident that most people filling out the survey are actively involved in the water management practices on their farm and are, thus, qualified to complete the survey.

The 14-question survey instrument included multiple choice questions with some open text response options designed to understand growers' knowledge and practices related to agricultural water use in both production and postharvest stages, as well as their understanding of the microbial quality of agricultural water. Questions included grower age, farm location, water testing frequency, and water usage for both production and postharvest activities.

The data were analyzed in Qualtrics using the cross-tabulation analysis method *(10, 11)* (also known as contingency table analysis) to identify the growers' knowledge of microbial risks related to different water sources and how they handle those risks. Cross-tabulation analysis compares the results of different questions from the same respondent to gain more insight into grower water quality management behaviors based on the risk of their water source. For example, growers who indicated that they did not treat their water source but indicated that they used a municipal water source (which is treated by a third-party company) were considered to have a safe water management practice. The responses from questions related to production or postharvest water uses, treatment application status, and microbial water quality test frequency were classified by use of different water sources (surface, ground, and municipal water). The data from any questions that allowed respondents to provide an open-ended response were added to existing responses, or a new category of responses was added to the question, based on the key words in those responses. For example, a separate category was created for growers who wrote they used water from a rain barrel when selecting "other" water for their water source.

Growers were asked whether they were good agricultural practices (GAP) certified (rather than whether they were covered by the FSMA PSR) because the project team felt that growers would be more comfortable responding to the question of GAP certification, rather than FSMA PSR coverage. Accordingly, responses to the questions about water testing and water treatment were stratified based on grower GAP certification status. Although GAP certification is generally a produce buyer requirement and is not a regulatory requirement, many growers view certification as an opportunity to improve their likelihood of compliance with the PSR. Thus, many growers covered by the PSR also obtain GAP certification.

Because some respondents did not answer all of the survey questions, the total number of responses to each question related to water sources in the cross-tabulation analysis may be different. Additionally, the total number of responses for questions regarding agricultural water source use could differ because growers may have reported using more than one water source for one or more pre- or postharvest activities. To reduce item nonresponse bias, surveys with fewer than two-thirds of the questions completed were excluded from the final data analysis.

RESULTS AND DISCUSSION

Results

A total of 106 survey responses were received. Of the 103 responses included in the final data analysis, 51 (49.5%) were from Kansas, 50 (48.5%) were from Missouri, one (1.0%) was marked as unknown, and one (1.0%) did not complete the question. Growers completing the survey were in these age ranges: 18 to 29 (n = 18, 17.5%), 30 to 39 (n = 15, 14.6%), 40 to 49 (n = 26, 25.2%), 50 to 59 (n = 19, 18.5%), and above 60 (n = 25, 24.3%) years old. Most respondents (n = 90) were currently selling or planning to sell their produce to others. Most respondents (n = 87) were currently not GAP certified, as shown in *Table 1*.

Participants who indicated that they were currently growing fresh produce (n = 101) reported frequency of generic *E. coli* testing as follows: more than once a year (n = 14, 13.9%), once a year (n = 11, 10.9%), two to three times in the last 10 years (n = 11, 10.9%), once in the last 10 years (n = 7, 6.9%), never tested (n = 39, 38.6%). Some reported that a third-party water source tested their water (n = 19, 18.8%). Of Kansas growers, 31.4% (n = 16) said that they had tested their water in the past 10 years, compared with 55.1% (n = 27) of Missouri growers *(Table 1)*. Of the growers indicating they were GAP certified (n = 14), 10 (71.4%) reported testing their water more than once a year and six (46.2%) reported that they treated their postharvest water sources. Of the non-GAP-certified growers (n = 87), four (4.6%) tested their water more than once a year and 15 (17.4%) treated their postharvest water sources *(Tables 2 and 3)*. Because the questions inquiring about the type of water source used for production and postharvest applications allowed for more than one response, the total number of responses varied by question, as shown in *Fig. 1*.

Municipal (n = 48, 35.6%), well (n = 34, 25.2%), pond (n = 23, 17.0%), and rain barrel (n = 20, 14.8%) water sources were the most commonly reported sources of production water *(Fig. 1)*. Municipal (n = 67, 59.8%) and well water (n = 25, 22.1%) were the most commonly reported water sources for postharvest water. Based on the number of responses for each water source, respondents appeared to commonly utilize more sources of water for production applications (n = 135) than postharvest (n = 113) applications.

Participants also reported their applications of production and postharvest water *(Fig. 2)*. Of the survey respondents (n = 101), 90 (89.1%) indicated that they used production water in their operation. The three main reported uses of production water included irrigation (n = 90, 100%), mixing with crop sprays (n = 38, 42.2%), and mixing with fertilizers (n = 38, 42.2%). Of those growers that reported using water for irrigation, 70 (77.8%) reported using drip irrigation, 37 (41.1%) reported using overhead irrigation, and 20 (22.2%) reported using drip irrigation under plastic. Furthermore, 90 (89.1%) indicated that they used postharvest water in their operation. These growers reported their main uses of postharvest water to be for handwashing (n = 77, 85.6%), rinsing and washing produce (n = 73, 81.1%), and cleaning and sanitizing of food contact surfaces (n = 68, 75.6%). Other uses of postharvest water reported included ice making (n = 7, 7.8%), dunk tank cooling (n = 6, 6.7%), single pass or spray cooling (n = 4, 4.4%), and postharvest fungicide or wax applications (n = 3, 3.3%).

TABLE 1. Reported microbial water quality testing (*n* = 100) status and GAP certification status (*n* = 101) by state

	Kansas n (%)	Missouri n (%)	Total
Have tested water	16 (31.4)	27 (55.1)	43
Never tested water	25 (49.0)	13 (26.5)	38
Use third-party test results	10 (19.6)	9 (18.4)	19
Total	51	49	100
GAP certified	2 (3.9)	12 (24.0)	14
Working toward being GAP certified in the future	7 (13.7)	8 (16.0)	15
Not GAP certified	42 (82.4)	30 (60.0)	72
Total	51	50	101

TABLE 2. The frequency of microbial water quality testing by GAP certification status (*n* = 101)

	More than once/yr n (%)	Once/yr n (%)	2–3 times in last 10 yr n (%)	Once in last 10 yr n (%)	Never tested n (%)	Third-party water test n (%)	Total
GAP certified	10 (71.4)	0 (0.0)	1 (7.1)	1 (7.1)	0 (0.0)	2 (14.3)	14
Working toward being GAP certified in the future	1 (6.7)	3 (20.0)	1 (6.7)	0 (0.0)	8 (53.3)	2 (13.3)	15
Not GAP certified	3 (4.2)	8 (11.1)	9 (12.5)	6 (8.3)	31 (43.1)	15 (20.8)	72

TABLE 3. Treatment application status for postharvest water based on GAP certification status (*n* = 99)

	Apply treatment n (%)	No treatment applied n (%)	Total
GAP certified	6 (46.2)	7 (53.8)	13
Working toward being GAP certified in the future	3 (21.4)	11 (78.6)	14
Not GAP certified	12 (16.7)	60 (83.3)	72

Of survey respondents who indicated that they used production water in their operation ($n = 90$), 75 (83.3%) reported that they did not treat their production water. Of the respondents who reported treating their production water, four (4.4%) reported using chemical sanitizers, whereas 11 (11.1%) respondents indicated using physical methods such as sand filtration. Of survey respondents who indicated that they used postharvest water in their operation ($n = 90$), 68 (75.6%) reported that they did not treat their postharvest water. Fifteen respondents (16.7%) reported treating postharvest water with a chemical sanitizer and four (4.4%) reported using other treatments such as sand filtration or UV light. In a comparison of water treatment status and the water source used *(Fig. 3)*, six (6.7%) respondents reported using surface water (ponds, cisterns, or rain barrels) for postharvest use without applying any treatment.

When asked what other practices (besides treatment) growers used to maintain or improve production water quality, most ($n = 70$, 77.8%) respondents using production water in their operation indicated that they did not use any other

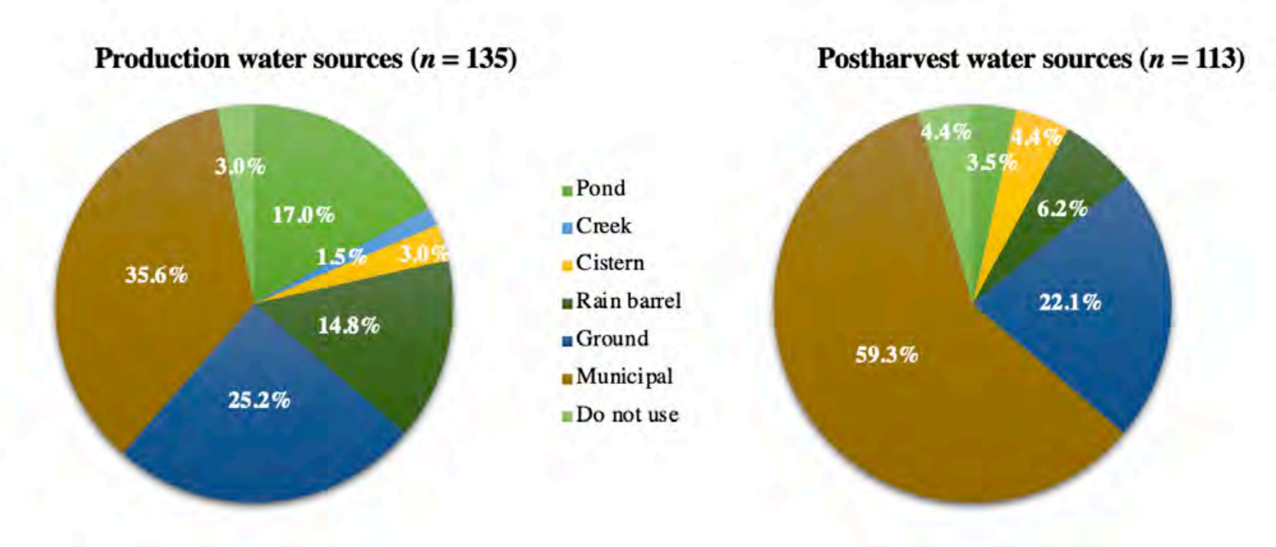

Figure 1. The percentages of different water sources that growers use for production (n = 135) and postharvest (n = 113) activities. (Note: among the 101 responses, several used more than one water type.)

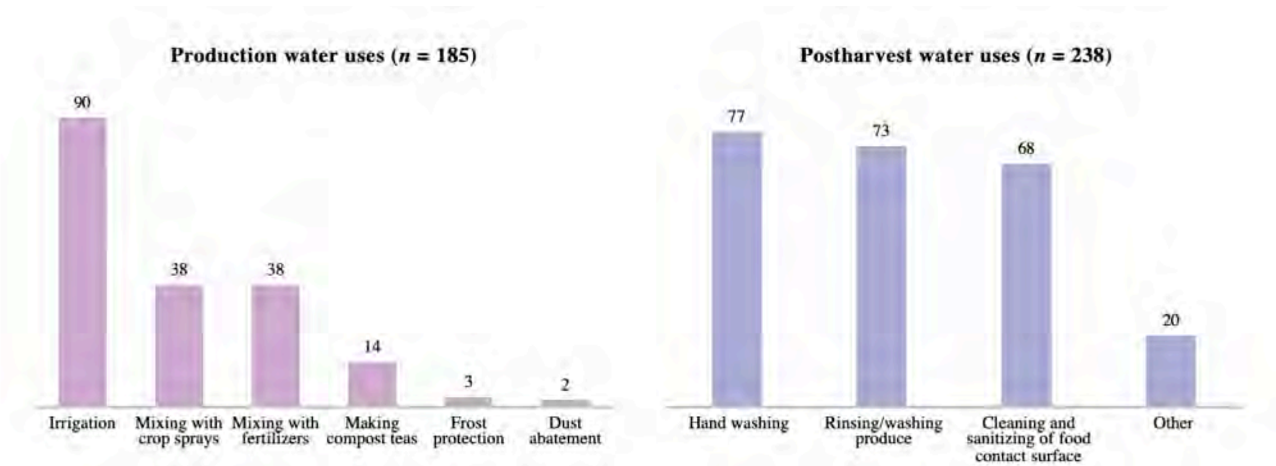

Figure 2. The different uses of production water (n = 185) and postharvest water (n = 238).

practices. Nineteen (21.1%) of the participants indicated that they conducted an annual evaluation of their water distribution system. In regard to managing the quality of their postharvest water, 61 (67.8%) respondents who indicated that they used postharvest water in their operation ($n = 90$) reported that they did not use any additional practices, 17 (18.9%) reported routine cleaning and sanitation of tanks, 15 (16.7%) reported monitoring for buildup of organic material, 14 (15.6%) reported conducting an annual evaluation, 10 (11.1%) reported monitoring water temperature during use, and nine (10.0%) reported using a routine water change schedule.

DISCUSSION

Agricultural water quality remains a large concern for the fresh produce industry across the United States, particularly in the Midwest, where previous studies indicate that agricultural water quality management is not well understood *(18)*.

Most of the respondents demonstrated a preference for water sources with a lower microbial risk profile (such as municipal water) for postharvest activities, as compared to using surface water postharvest, which is higher risk. Specifically, the survey data indicate that—unlike production water, for which municipal (35.6%) and surface water use (36.3%) were nearly equally reported—there was a higher use of municipal water (59.3%) and lower use of surface water (14.1%) for postharvest applications *(Fig. 1)*. As previous research has shown, microbial populations in surface water increase after events such as agricultural runoff (rain, melted snow, etc.) *(3, 24, 27)*. Surface water is also more exposed to potential contamination from the surrounding

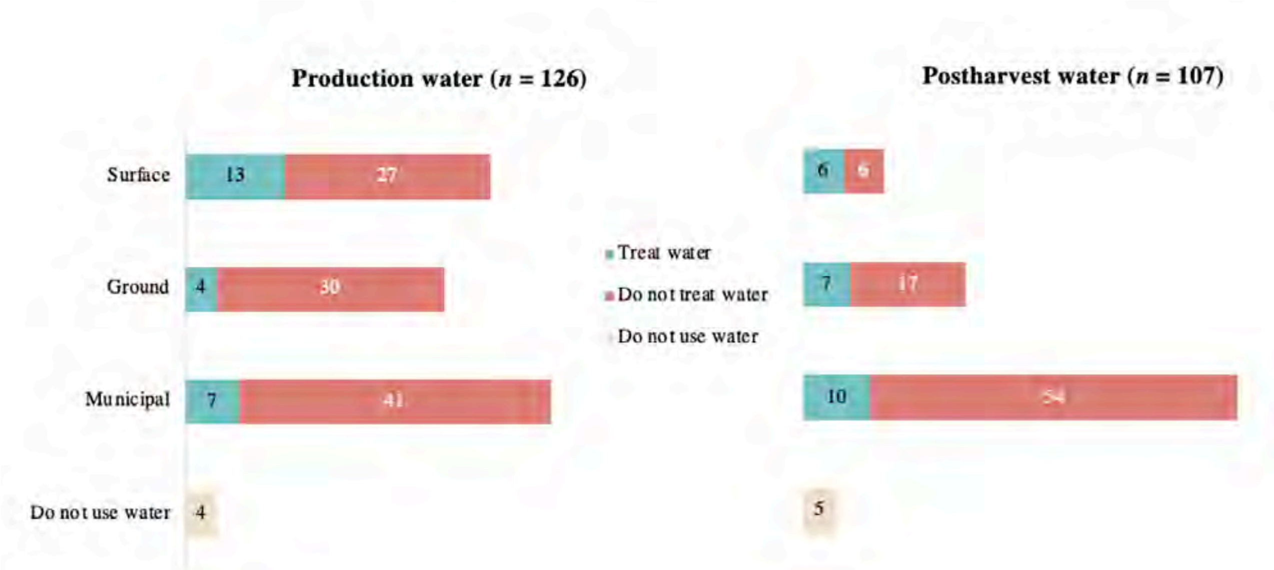

Figure 3. Treatment status for each water source that growers use for production (n = 126) and postharvest (n = 107) activities.

open environment and, thus, is considered to have a higher possibility of contamination *(1, 8, 23)*.

According to the data collected from the survey, a minority of growers used specific postharvest water management practices that many would consider higher risk. Using surface water without any treatment for postharvest applications poses a higher risk of foodborne disease outbreaks; accordingly, the FSMA PSR agricultural water criteria, GAP certification requirements, and general produce safety best practices do not allow use of untreated surface water for postharvest activities *(31)*. Interestingly, six survey respondents indicated that they were using untreated surface water for postharvest uses, and eight respondents indicated they treated their agricultural water using methods such as sand (bio)filtration. Of note, sand filtration is not a validated agricultural water treatment method according to the FSMA PSR (21 CFR 112.43) *(31)*. However, growers do currently utilize sand filtration in irrigation systems to remove larger physical particles, sometimes with the misconception that it also can remove pathogens. This indicates that further education and training is needed to emphasize the significance of microbial risk in postharvest water and to provide information on how to select an appropriate (validated) treatment method.

Conducting regular inspection and maintenance of the water source and distribution system is currently a requirement of the FSMA PSR (21 CFR 112.42) *(31)* and is a produce safety best practice to limit the risk of microbial contamination. By conducting regular inspections, growers can evaluate the risks to their water sources. Inspection includes identification of any broken part of the system structure and any evidence of wildlife around open water sources, among other risks. Most of our survey respondents were not currently conducting an annual agricultural water system inspection. Thus, extension educators should provide practical information to growers on how to inspect their water sources regularly and encourage them to conduct a water system inspection at least annually, which is a requirement for growers covered by the FSMA PSR (21 CFR 112.42) *(31)*. Of note, the proposed §112.43 is intended to supplement the requirements of the proposed §112.42, which will require a covered farm to regularly inspect and routinely maintain the components of its agricultural water system. Whereas proposed §112.42 is focused on agricultural water system components, the proposed §112.43 would require covered farms to conduct a more comprehensive assessment of possible sources and routes by which known or reasonably foreseeable hazards are reasonably likely to be introduced into its preharvest agricultural water *(32)*.

The FSMA PSR also highlights irrigation method as an important risk factor for contamination risk based on whether the water contacts the harvestable portion of the produce. In most situations, overhead irrigation results in direct contact with the harvestable portion of the produce, which can result in a higher contamination risk than other irrigation methods. Conversely, drip irrigation (particularly drip irrigation under plastic) is considered to have a relatively lower risk of contamination for crops grown above the ground. Of note, this characterization does not apply to root crops, such as carrots, beets, and radishes *(25)*. Most of the survey respondents indicated that their main use of production water was irrigation, namely drip irrigation (69.1%) or overhead irrigation (31.3%). However, the findings of the study call attention to particular agricultural water practices, including the use of untreated surface water for direct water application during postharvest and the lack of regular testing of the sanitary quality of agricultural water sources. Although not specifically measured by this study, further investigation and, potentially, extension efforts may be needed to clarify how growers can reduce microbial risk by selecting irrigation methods that reduce the probability of water contact with the harvestable portion of the produce.

In the survey, the question about the frequency of conducting microbial water testing did not specify testing frequency of "production water" and "postharvest water" separately. Accordingly, cross-tabulation analysis for the frequency of water testing for different sources of water used for different purposes (pre- or postharvest) could not be conducted. Moreover, it was not possible to discern between treated and untreated sources when more than one source was indicated by the grower in this survey. We also did not include questions related to the location of their water source in relation to animals or other potential sources of contamination. These points could have been clarified by increasing the length of the survey. However, the expert panel that reviewed the survey was concerned about the adverse effect that increasing the survey length could have on the response rate because some participants required more than 10 minutes to complete the survey. In a study of the effects of length on web-based survey completion, Galesic and Bosnjak *(9)* found that participants anticipating a longer survey completion time were less likely to finish the survey.

CONCLUSIONS

This survey was intended to provide information on the differences between best practices and the actual practices of Kansas and Missouri produce growers, with a focus on the use of agricultural water. Produce growers need to continue to improve their practices related to water quality to ensure that they are selling the safest produce possible. The survey responses will provide insight into the development of additional agricultural water safety educational materials for produce growers. The results indicate that continued efforts are needed to encourage growers to test their water quality, to conduct at least an annual inspection of water sources and distribution system, and to treat surface water with a validated method before using it for postharvest applications. The authors suggest that future extension trainings should emphasize the importance of the microbial quality of agricultural water sources, with information about how risk to produce safety can be affected by selection of water source, decision to treat, and (in the case of production water) application method.

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APPENDIX 1. Knowledge and current practices related to agriculture water survey

Hello,

We would like to invite you to complete a short research survey. Completing the survey will take about 5 minutes.

Kansas State University (KSU), the University of Missouri (MU), and Lincoln University (LU) are conducting a survey of Kansas and Missouri produce growers to learn more about your knowledge and current practices related to the quality of water used for produce on your farm. The goal of this survey is to learn more about the current level of knowledge and practices in this area so that we can more effectively design educational and other outreach materials to help growers to improve or maintain the quality of their water to grow safe produce.

Your identity will be kept completely anonymous in the survey results. Only group comparisons will be made and reported in summary form. Your participation is entirely voluntary, and you may withdraw from participation at any time without penalty. Identifiers will be removed from any identifiable private information, and, after such removal, the information could be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you, the survey participant.

If you are interested, you can register your name and contact information on a separate list (which will not be connected with your survey results) to enter a drawing to win one of two $50 Visa gift cards that are available to survey respondents. If you have any questions about the survey or would like a copy of the summarized results, please contact Dr. Londa Nwadike (lnwadike@ksu.edu), state Extension Food Safety Specialist for KSU and MU. Telephone: +1 913.307.7391. Mailing address: 22201 W. Innovation Dr., Olathe, KS 66061.

If you have questions about the rights of human research subjects, you should contact Heath Ritter at hlr@ksu.edu or +1 785.532.3234.

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1. **What is your age?**
   - ❑ 18-29
   - ❑ 30-39
   - ❑ 40-49
   - ❑ 50-59
   - ❑ 60+ years

2. **Are you currently Good Agriculture Practices (GAP) certified?**
   - ❑ Yes
   - ❑ No
   - ❑ No, but working towards being GAP certified in the future

3. **Are you currently raising produce (fruits, vegetables, herbs, mushrooms, nuts) for sale?**
   - ❑ Yes
   - ❑ No
   - ❑ No, but plan to in the future

4. **In which state do you grow produce? (If more than one, mark the primary state)**
   - ❑ Kansas
   - ❑ Missouri
   - ❑ Other ___________

5. **Do you currently use water Preharvest in your produce operation? (check all that apply)**
   - ❑ For irrigation
   - ❑ For mixing with crop sprays
   - ❑ For mixing with fertilizers
   - ❑ For making compost teas
   - ❑ For dust abatement
   - ❑ Frost protection
   - ❑ Other _______
   - ❑ No

6. **If you use water for irrigation, how do you irrigate? (check all that apply)**
   - ❑ Drip irrigation
   - ❑ Drip irrigation under plastic
   - ❑ Overhead irrigation
   - ❑ Furrow irrigation
   - ❑ Other _______
   - ❑ I do not irrigate

7. **What sources of Preharvest water do you use? (check all that apply)**
   - ❑ Pond
   - ❑ Creek
   - ❑ Well
   - ❑ Municipal water
   - ❑ Cistern
   - ❑ Other (such as rain barrel, spring, or others. Please list) ________________
   - ❑ Do not use water preharvest

8. **Do you currently use water Postharvest in your operation? (check all that apply)**
   - ❑ Rinsing/ washing produce
   - ❑ Commodity movement (i.e., dump tanks/flumes)
   - ❑ Single-pass/spray cooling
   - ❑ Dunk tank cooling
   - ❑ Ice making
   - ❑ Postharvest fungicide or wax
   - ❑ Handwashing
   - ❑ Cleaning and sanitizing of food contact surfaces
   - ❑ Other (please list)________________

9. **What sources of post-harvest water do you use? (check all that apply)**
   - ❑ Municipal water
   - ❑ Well
   - ❑ Cistern
   - ❑ Pond
   - ❑ Creek
   - ❑ Other (such as rain harvest barrel or others. Please list) ________________
   - ❑ Do not use water postharvest

10. **Do you test your water used in your produce operation for generic *E. coli*?**
    - ❑ Yes, more than once a year
    - ❑ Yes, once a year
    - ❑ Yes, we have tested our water 2-3 times in the last 10 years or so
    - ❑ Yes, we have tested our water once in the last 10 years or so
    - ❑ No, we have never tested our water
    - ❑ A third party (such as the municipal supplier)

11. **Do you treat your water used Preharvest (such as in irrigation) to improve its microbial quality?**
    - ❑ Yes, we treat it with a sanitizer (list sanitizer used) _____________
    - ❑ Yes, we use a different treatment (list treatment- for example, sand filter, other) ________
    - ❑ No

12. **Do you treat your water used Postharvest (such as in washing) to improve its microbial quality?**
    - ❑ Yes, we treat it with a sanitizer (list sanitizer used) _____________
    - ❑ Yes, we use a different treatment (list treatment- for example, sand filter, ozone, UV, reverse osmosis, other) _______________
    - ❑ No

13. What other practices (besides treatment) do you use to maintain/improve the quality of the water used Preharvest in your produce operation?

- ❏ We conduct an annual evaluation of our water distribution system
- ❏ Other (please list)________________________
- ❏ None

14. What other practices (besides treatment) do you use to maintain/improve the quality of the water used Postharvest in your produce operation?

- ❏ We conduct an annual evaluation of our water distribution system
- ❏ Routine water change schedule
- ❏ Routine cleaning and sanitation of tanks
- ❏ Monitoring for buildup of organic material
- ❏ Monitoring water temperature during postharvest use
- ❏ Other (please list)________________________
- ❏ None

Thank you for your time. We appreciate your participation in the survey and value your input.