ONION STORAGE IN STERILIZED NEW PLASTIC CRATES COMPARED TO STORAGE IN OLD WOODEN BOXES

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Abstract

The United States Food and Drug Administration's (FDA) proposed water rules to implement the Food Safety Modernization Act (FSMA). The FDA has proposed that plastic totes be substituted for wooden bins for the storage on onion bulbs. A preliminary study was conducted to examine the role of wooden storage containers on onion bulb contamination with *E. coli*. Onions from a furrow-irrigated field using water up to 866 MPN *E. coli* /100 ml were harvested into 12 old wooden boxes and 12 sterilized new plastic crates. Onions from a drip-irrigated field using water with 0 MPN *E. coli* /100 ml were harvested into 12 old wooden boxes and 12 sterilized new plastic crates. Onions packed out tended to not have *E. coli* on the bulb exteriors. The small amount of contamination detected did not appear to be related to the storage containers or irrigation water source.

Background

The Food Safety Modernization Act, signed into law in January 2011, is the first major federal reevaluation of food safety since 1938. It charges the FDA with ensuring the safety of the U.S. food supply by acting preventively rather than reactively to foodborne illness outbreaks. One of the new regulations the FDA has proposed for the production of vegetables are provisions that plastic totes be used to store onions instead of wooden bins. It is unknown whether onion storage in wooden crates or bins contributes to *E. coli* counts on onion bulbs at packout. The FDA requirement to convert from wooden crates to plastic totes would be very costly and might provide no human health benefits. We sought to determine whether or not onion storage in new sterilized plastic crates would be more effective in minimizing *E. coli* contamination on the exterior of packed out onion bulbs than those stored in old, unwashed wooded boxes.

Materials and Methods

'Vaquero' onions drip-irrigated with clean well water were compared with Vaquero onions irrigated with contaminated ditch water. Onions were grown side-by-side on Greenleaf silt loam at the Oregon State University Malheur Experiment Station, Ontario, Oregon in 2013. Both irrigations systems were in the same field with onions grown in the same way except for the irrigation system. The seed was from the same lot, the seed was planted on the same day, and most operations were identical. Prior to harvest, onions in the field were tested for the presence of salmonella or E. coli inside the bulbs. Irrigation water sources were evaluated for *E. coli* several times during the growing season. The final irrigation occurred on 30 August. The onions were lifted mechanically on 10 September 2013.

Analysis of *Salmonella* and *E. coli* inside the bulbs

The outer skins and scales were peeled from all the onions in 15-bulb sample (one from the furrow-irrigated onions and one from the drip-irrigated onions), and the bulbs were placed on an aluminum tray. The exterior of the peeled onions were disinfected with 70 % ethanol and placed on a sterilized aluminum tray. The alcohol was allowed to evaporate. A wedge was cut out of each onion. The wedges were placed in a sterilized zip-lock food grade bag and mixed. A sterilized stainless steel beaker was filled with mixed onion wedges and the remainder of the onion wedge sample was placed in a refrigerator. The cut onion wedges in the stainless steel beaker were macerated with a food processer (Waring commercial immersion blender; model WSB) in the stainless steel beaker. After maceration, 10 ml of the resulting onion suspension was placed in 90 ml of Universal Pre-enrichment broth (UPB, Accumedia, Nedgen Michigan) and sealed. The UPB broth was placed in an incubator for 48 hours at 35^{o} C.

Along with every batch of samples, an additional positive inoculated sample was placed in an additional flask containing UPB broth. After 48 hours in UPB, 1 ml of the UPB was transferred to TT Broth Base (Hajna, Remel) for *Salmonella*. The TT broth was incubated for 24 hours at 41.5^{o} C. A blue jar with 100 ml sterilized water had a package of Colisure (Idexx) added for the presence of *E. coli*. Five ml of the UPB was transferred to Colisure mixture and incubated for 24 hours at 35^{o} C. After 24 hours the TT broth was tested with *Salmonella* Rapid check (SDIX) for presence of *Salmonella* and the Colisure was tested with UV light for the presence of *E. coli.*

Comparison of plastic crates and old wooden boxes

About 30 onions from the drip-irrigated area of the field were topped 18 September into 12 sterilized new plastic crates and into 12 un-sanitized old wooden boxes. About 30 onions from the furrow-irrigated area were topped into 12 sterilized new plastic crates and into 12 un-sanitized old wooden boxes (Figure 1). All harvest and handling operations were done with sterile gloves, sterilized knives, and sterilized harvest baskets. All boxes and crates were placed into the same onion storage (Figures 2 and 3). The storage conditions were monitored. Fifteen bulbs were packed out from each plastic crate and from each wooden box (Figure 4). New sterile gloves and a freshly sterilized packing table were used for every packout sample. Bulbs were placed into double-bagged 13-gallon trash bags labeled accordingly. The harvest and packout removed the loose skin and most of the attached roots and soil. Following packout, the bulb exteriors were analyzed for *E. coli*. Packout occurred on 14 and 15 October 2013 to allow time to analyze the data and promptly share the results. Remaining onions were returned to the same crate or box and returned to storage without packout. The remaining onions were packed out of one onion crate and one old wooden box on 21 October.

External analysis of onion bulbs for *E. coli*

In the laboratory the roots, small remnants of soil, skins, and outer peel of the 15 onions were removed from the bulbs and weighed. They were then thoroughly washed in one liter of water. A 100ml sample of the wash water was used to estimate a Most Probable Number (MPN) using IDEXX *Colilert*® +*Quanti-Tray/2000*® (IDEXX Laboratories, Westbrook, ME) of *E. coli* from the outside of the onions. The *E. coli* MPN per onion bulb exterior was calculated.

Analysis of the soil for *E. coli*

Soil from the top 2 inches (5 cm) was sampled 18 September and analyzed for *E. coli*. A single composite soil sample was taken from 20 random spots where the 12 rows of drip-irrigated onions were harvested and a single composite soil sample was taken from the 12 rows where the furrow-irrigated onions were harvested. Soil samples were refrigerated until analyzed. Part of each soil sample was weighed wet, dried, and weighed dry to determine the soil water content. Separately, 50 g of each soil sample was diluted in 75 ml of water and shaken. Then 50 ml of the water was removed and was used to estimate a Most Probable Number (MPN) of *E. coli* in the soil water using IDEXX *Colilert*® +*Quanti-Tray/2000*® (IDEXX Laboratories, Westbrook, ME).

Figure 1. Onion harvest of drip- and furrow-irrigated onions into new sterilized plastic crates and old wooden boxes, Oregon State University Malheur Experiment Station, Ontario, Oregon, 18 September 2013.

Figure 2. Onions stored in new sterilized plastic crates, Oregon State University Malheur Experiment Station, Ontario, Oregon, 2013.

Figure 3. Onions stored in old wooden boxes, Oregon State University Malheur Experiment Station, Ontario, Oregon, 2013.

Figure 4. Onions being graded out of storage, Oregon State University Malheur Experiment Station, Ontario, Oregon, 14 October 2013.

Results

The irrigation water was tested several times during the season from 551 to 866 MPN of *E. coli* per 100 ml and 0 MPN of *E. coli* per 100 ml for the ditch and drip water sources, respectively. The onion interiors tested negative for *E. coli* and salmonella at harvest. The soil tested negative for of *E. coli* in the upper 5 cm of soil, irrespective of irrigation system.

Furrow-irrigated onion packout: plastic crates vs. old wooden boxes

The onions that were grown under furrow irrigation had no *E. coli* on the bulb exteriors after packout (Table 1). The absence of *E. coli* occurred in spite of the presence of *E. coli* in the irrigation water. It is probable that the bulbs had *E. coli* on their surface at the time of harvest given the results reported by Shock et al. (2013), but the *E. coli* failed to survive. Since no *E. coli* was found on any of the packed out onions, onion storage in old wooden boxes did not contribute any additional *E. coli* contamination to the onion bulbs compared to storage in sterilized new plastic crates (Table 1).

Drip-irrigated onion packout: plastic crates vs. old wooden boxes

The onions that were grown under drip irrigation had little *E. coli* on the bulb exteriors after packout (Table 2). The *E. coli* occurred on the exterior of onions from one of the twelve sterilized new plastic crates and one of the old wooden boxes in spite of the absence of *E. coli* in the irrigation water. It is probable that some of the bulbs had *E. coli* on their surface at the time of harvest following drip irrigation with water lacking *E. coli* given the results reported above (Shock et al. 2013). Since the *E. coli* were found on the one sample of onions packed out from a plastic crate and one sample from the old wooden box, the *E. coli* could have come from the

random contamination of the bulbs during the growing, curing, harvest, contact with onion containers, packout, or laboratory steps of analysis. In order to try to distinguish between the role of the plastic crate and old wooden boxes where *E. coli* contamination was found and other possible sources of contamination, the remainder of the onions was packed out from the plastic crate and wooden box where *E. coli* was detected after packout 14 October 2013. No *E. coli* was detected on the remaining onions (Table 2).

Table 1. *E. coli* on furrow-irrigated onions packed out of storage from new sterilized plastic crates and old un-sanitized boxes, Oregon State University, Malheur Experiment Station, Ontario, Oregon, 2013.

Storage containers	Average weight of skins, peel, roots, and soil on 15 October 2013 (g/bulb)	Average MPN external *E. coli* per onion on 15 October 2013
Sterilized new plastic crates	5.9	0
	5.8	0
	6.8	0
	8.4	0
	5.9	0
	7.5	0
	10.9	0
	7.3	0
	5.6	0
	7.9	0
	4.6	0
Old wooden boxes	6.5	0
	6.5	0
	7.6	0
	5.2	0
	4.0	0
	6.9	0
	6.8	0
	6.6	0
	5.7	0
	5.1	0
	7.6	0
	4.9	0
	6.5	0

Table 2. *E. coli* on drip-irrigated onions packed out of storage from new sterilized plastic crates and old un-sanitized boxes, Oregon State University, Malheur Experiment Station, Ontario, Oregon, 2013.

Storage containers	Average weight of skins, peel, roots, and soil on 15 October 2013 (g/bulb)	Average MPN external *E. coli* per onion on 15 October 2013	Average weight of skins, peel, roots, and soil on 21 October 2013 (g/bulb)	Average MPN external *E. coli* per onion on 21 October 2013
Sterilized new plastic crates	10.4	0		
	7.5	0		
	6.4	0		
	6.1	0		
	8.5	0		
	12.8	0		
	9.2	0		
	8.9	0		
	8.4	13	7.2	0
	7.6	0		
	7.2	0		
Old wooden boxes	13.0	459	11.6	0
	6.5	0		
	6.5	0		
	7.6	0		
	5.2	0		
	4.0	0		
	6.9	0		
	6.8	0		
	6.6	0		
	5.7	0		
	5.1	0		
	7.6	0		
	4.9	0		

Discussion

Very few *E. coli* were detected on the exterior of onions at packout. Neither new sterilized plastic crates nor old wooden boxes seemed to be conducive to *E. coli* of stored onion.

Although 24 of the 48 storage containers contained onions produced with furrow irrigation water that contained considerable *E. coli,* these furrow-irrigated onions were no more apt to have *E. coli* on the bulb exteriors at packout than the side-by-side drip-irrigated onions. These results are consistent with the previous findings (Shock et al. 2013) where *E. coli* on onions after lifting seemed to 1) be unrelated to *E. coli* in the irrigation water, 2) be a random occurrence, and 3) largely fail to survive on onion bulbs during curing. The small amount of E. coli found on onion exteriors was unrelated to either *E. coli* in irrigation water or the use of a particular type of storage container.

Further studies are warranted to determine where late stage *E. coli* contamination on onion bulb exteriors comes from and the proportion of bulbs that have such contamination.

References

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