Let's cut the rug: investigating food safe alternative materials for watermelon post-harvest activities

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INTRODUCTION

Carpet used in watermelon harvesting activities functions to cushion the product during transport, however, this absorbent material provides a niche for unwanted microbial growth and is difficult to effectively clean, sanitize, and maintain in a sanitary manner. Further, competing priorities and limited resources on farms render it difficult to perform in-house evaluation of suitable alternatives for watermelon harvesting buses. **This work aims to 1) construct an alternative food contact surface for watermelon harvesting and 2) evaluate if the alternative is: easily maintained and sanitizable, durable, protective to melon quality, and economically feasible.**

METHODS

Table 1: Description of surface types involved in this study.

Bus anatomy	Materials used in alternative surface installs		Control buses	Food contact surface?
	"Option one"	"Option two"		
Wall sub-liner material	Existing cushion	Pro-85 Foam from GrowUSA®	N/A	No
Wall liner material	610.30 GSM (g/m^2) vinyl liner From GrowUSA®	610.30 GSM (g/m^2) vinyl liner From GrowUSA®	Various	Yes
Floor material	1.27 cm rubber floor mats	1.27 cm rubber floor mats	Various	Yes

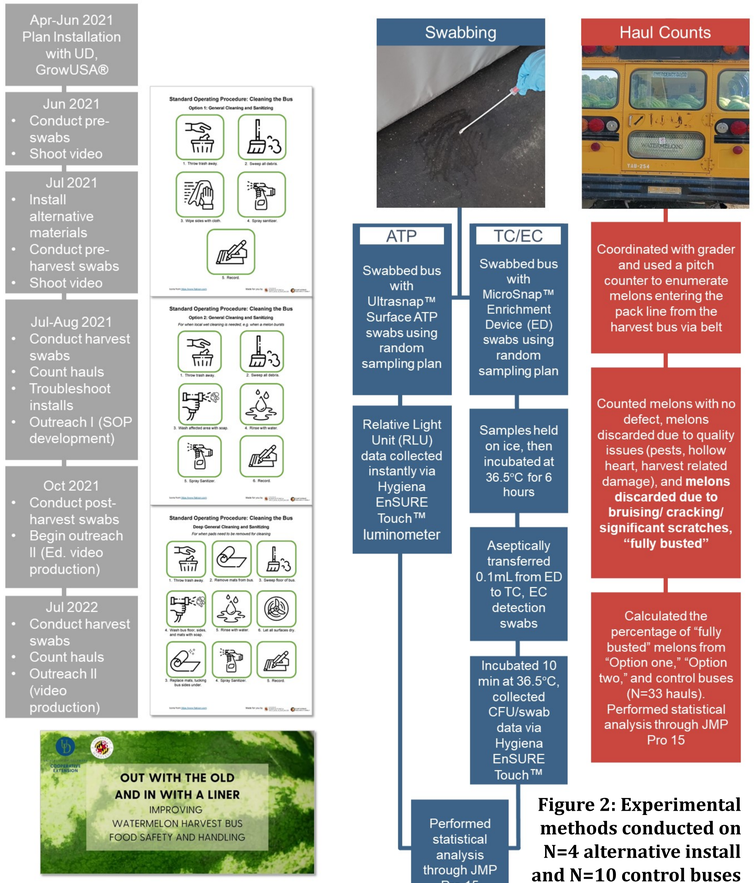

Figure 1: Project timeline. Outreach SOP's and educational video highlighted.

Figure 2: Experimental methods conducted on N=4 alternative install and N=10 control buses 2021-2022. TC=Total coliform, EC=*E. coli*

RESULTS

Figure 3: Photos of bus installations throughout one year of use display durability of materials and installation strategy. (A) Pre-install bus, (B) Post-install July 2021 of non-porous liner over existing cushion, "Option one", (C) "Option one" liner attached to side of bus post-install July 2021, (D) Post-install July 2021 of non-porous liner sewn over Pro-85 foam cushion, "Option two", (E) "Option two" liner attached to side of bus July 2021, (F) Post-season October 2021 of "Option one", (G) Post-season October 2021 of "Option two", (H) In-season July 2022 of "Option one", (I) In-season July 2022 of "Option one" side of bus, (J) In-season July 2022 of "Option two", (K) In-season July 2022 of "Option two" side of bus.

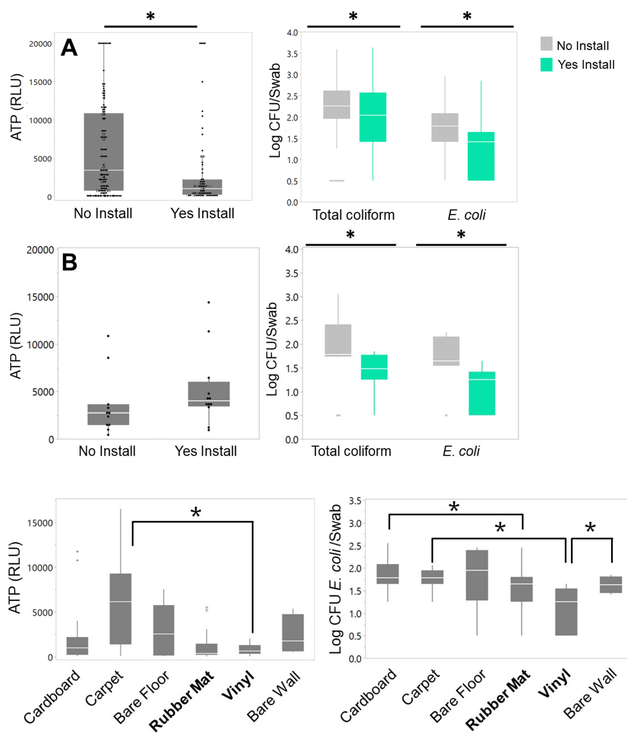

Figure 4: Buses with installations of alternative surfaces returned significantly lower ATP, Total coliform (TC), and *E. coli* (EC) concentrations in year one and significantly lower TC and EC in year two compared to buses with no intervention. Outlier box plots display all time points, all locations pooled of (Panel A) year one, N=168 samples per swab type and (Panel B) year two, one location N=24 samples per swab type. Asterisks denote significance between buses with alternative surfaces and control buses (ATP X^2 (1, N=164)= 11.7, p=0.0006; TC and EC evaluated via orthogonal contrasts p<0.05, α=0.05.

Figure 5: Considering various surface types present in buses, the vinyl wall alternative surface displayed significantly lower ATP, *E. coli* compared to carpeted wall and significantly lower *E. coli* compared to a bare wall. The Rubber mat floor alternative surface also exhibit significantly lower *E. coli* compared to cardboard floor surfaces. Outlier box plots display year one harvest time points (N=104), all locations pooled. Asterisks denote significance between surface types via orthogonal contrasts (α=0.05).

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RESULTS

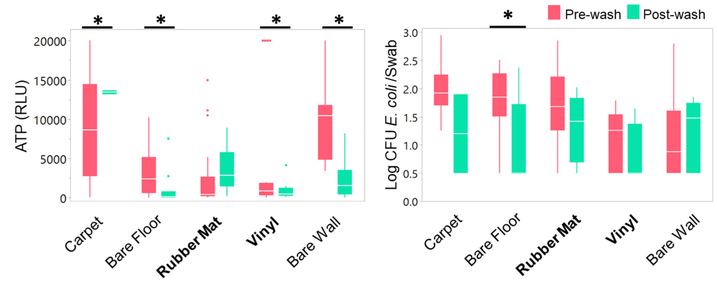

Figure 6: Washing procedures reduced ATP levels on most materials except carpet wall surface and rubber mat floor, whereas *E. coli* levels were only significantly reduced on bare floor after washing. Outlier box plots display year one (N=148), all time points and locations pooled. "Washing" is a general term as protocols were farm specific and did not always include sanitization. Asterisks denote significance between pre-wash and post-wash via Student's T Test (α=0.05).

Table 2: Percent of melons discarded due to issues in transport from 2021 (N=33 hauls) and 2022 (N=6 hauls) show that alternative surface install buses suffer significantly fewer melon losses than carpeted control buses (2021 Tukey HSD, 2022 Student's T test, (α=0.05).

Year	Bus treatment	Number of melons packed per haul	Percent melons discarded due to issues in transport per haul	
		Mean±SD	Mean±SD	
2021	Install	1357.93±138.83	0.10±0.13	**B**
	Carpet	1238.86±213.69	0.41±0.27	**A**
	No carpet	1211.4±112.02	0.19±0.21	**AB**
2022	Install	1368±50.48	0.07±0.0027	**B**
	Carpet	1205.3±66.00	0.5±0.31	**A**

CONCLUSIONS

- **Durability:** Visual assessment of the installations paired with regular use by study participants demonstrate the durability of this alternative food contact surface design.
- **Sanitary maintenance:** ATP, *E. coli* results indicate buses with alternative surface installs can be maintained in a sanitary manner.
- **Sanitization ability:** washing procedures did not significantly reduce *E. coli* levels on vinyl wall surfaces, however concentrations of *E. coli* on these surfaces were consistently low pre- and post-wash.
  - Future work opportunity: due to the variability of in-field washing procedures, effect of sanitization on surface material harborage would benefit from controlled, repeated experimentation.
- **Protective to melon quality and Economic feasibility:** both install strategies save significantly more melons from cull compared to carpeted buses. "Option one" (cost $399) saves 1734 melons per season and will pay for itself in 10 harvest days, while "Option two" (costs $2371) saves 2567 per season and will pay for itself over a 45 day harvest season.
  - Future work opportunity: collaborations with state agencies and harvesting companies could result in cost-share programs, providing mutual benefit.