# Characterization and mitigation of food safety risks associated with waxing roller brushes


## Contact
Luxin Wang, PhD
University of California, Davis
lxwang@usdavis.edu

## Authors
Zhuo Chen, Yucen Xie, Jiahan Zou, Gang Sun (Co-PI), Luxin Wang (PI)



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## Summary
Waxing roller brushes made with different patterns and materials play an important role during the application of waxes onto fruit surfaces. However, food safety risks associated with waxing roller brushes have not been well characterized, and the cleaning and sanitizing of roller brushes have been challenging for the industry. This study addresses the needs of the produce industry by better characterizing the impact of waxes on the survival and changes of microorganisms on brushes made with different materials (nylon versus 50% horsehair/50% polyethylene [50/50]) and of different patterns (spiral versus tufted), and by evaluating and optimizing cleaning and sanitizing protocols for waxing roller brushes.


## Objectives
1. Investigate the bacterial behavior on different waxing roller brushes with and without the presence of waxes.
2. Evaluate the levels of indigenous microbial populations present on waxing roller brushes in Californian commercial packinghouses.
3. Characterize the physical and chemical properties of hydrolyzed waxes and optimize and validate the cleaning and sanitizing protocols for effective removal of wax residues and microorganisms from waxing roller brushes.

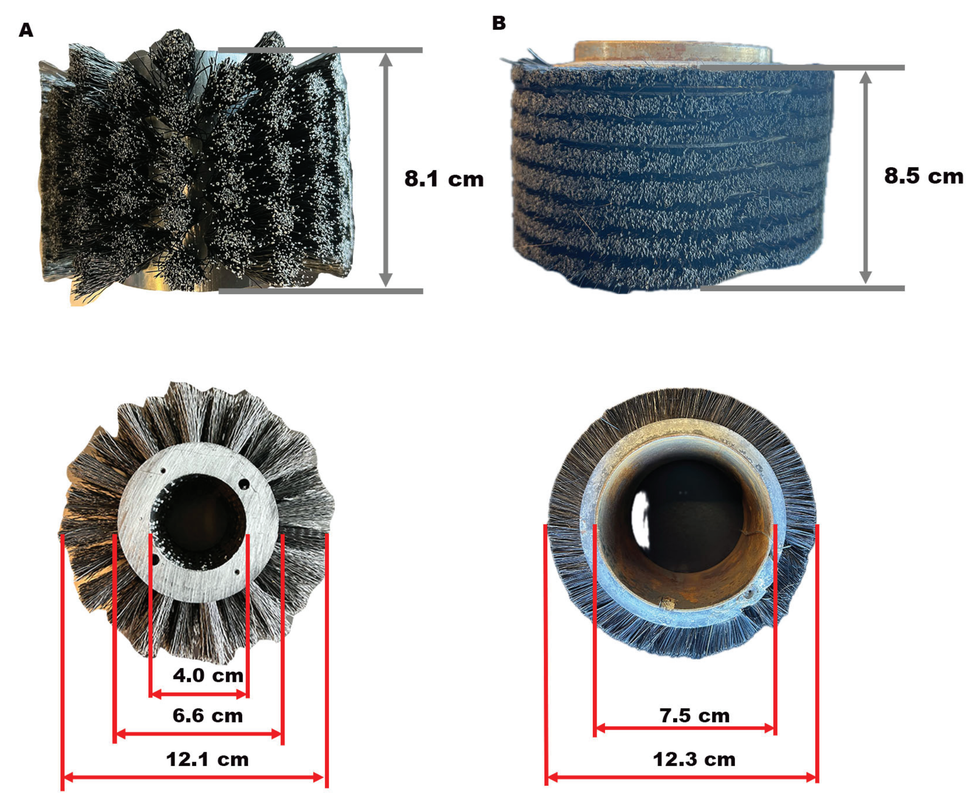
## Methods
**Impact of brush patterns and filament materials on the microbial attachment:** *Enterococcus faecium* (EF) as the surrogate for *Listeria monocytogenes* (LM) was selected to investigate the impact of brush patterns (spiral versus tufted) and filament materials (nylon versus 50/50) on the attachment of bacteria. The brush coupons (**Figure 1**) were dip-inoculated with EF at ~8 log CFU/coupon, and the EF populations after inoculation and after 48-h drying were confirmed.

**Survival of LM on tufted brushes:** Five LM strains associated with fresh produce outbreaks were selected. A 5-strain LM cocktail was prepared and spot inoculated on unwaxed tufted brushes at ~8 log CFU/coupon. The dried inoculated brush coupons were individually packed and stored at ambient conditions. The survival of LM on brushes was monitored.

## Results to Date
Approximately 8 log CFU/coupon of EF was attached on waxing roller brushes (spiral-nylon, spiral-50/50, tufted-nylon, and tufted-50/50) immediately after the dip inoculation. After drying in the biosafety cabinet with running airflow for 48 h, the population of EF declined more on nylon brushes (~2 log/coupon) than on 50/50 brushes (~1 log/coupon), regardless of brush patterns (**Figure 2**).

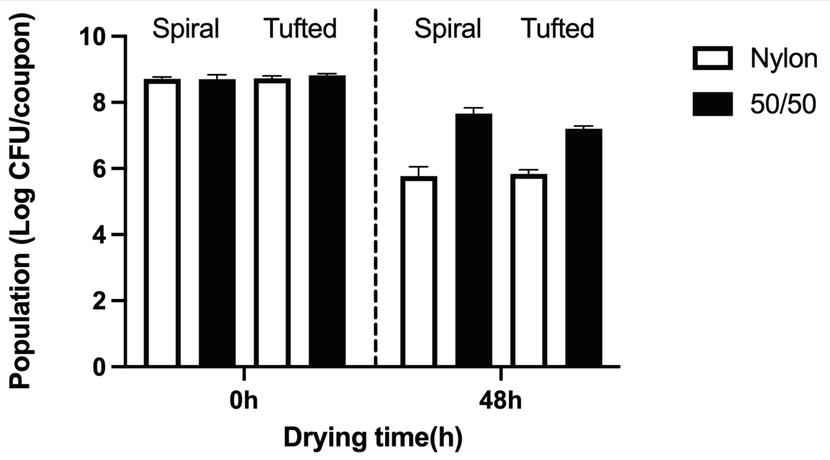
After 14 days of storage, the population of LM further declined by ~2 and ~1 log/coupon on nylon and 50/50 tufted brushes, respectively (**Figure 3**).

## Benefits to the Industry
Results of this study will bridge the knowledge gaps on how different brush patterns, filament materials, and the presence of wax residues influence pathogen survival on waxing roller brushes, and the effectiveness of current cleaning and sanitation protocols on the removal of different wax residues as well as microorganisms. Outcomes will assist the design, optimization, and validation of protocols used by the industry for the cleaning and sanitizing of waxing roller brushes, thus mitigating microbial safety risks associated with waxing.



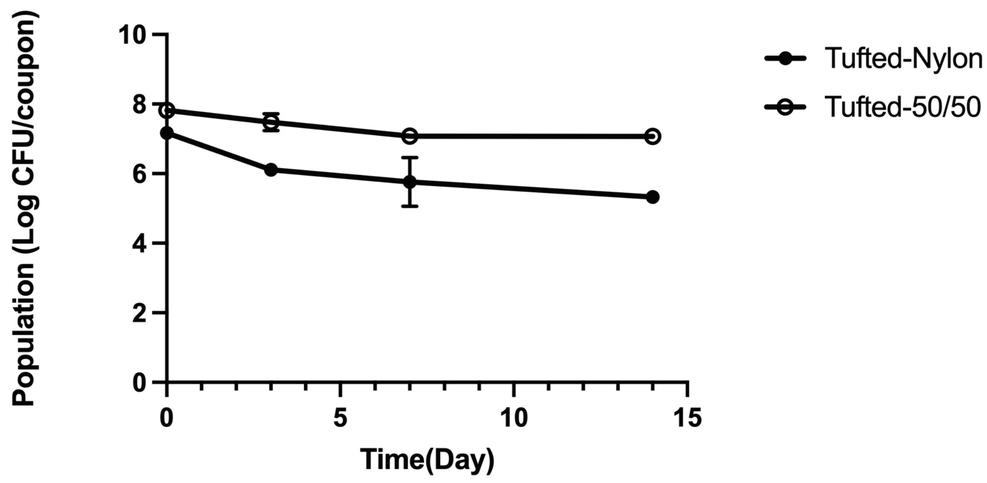

**Parameters of tufted (A) and spiral (B) patterned brushes with two different filament materials (nylon versus 50% horsehair/50% polyethylene [50/50]).**

**Figure 1**




**Attachment of *Enterococcus faecium* on unwaxed brushes as influenced by patterns (spiral versus tufted) and filament materials (nylon versus 50% horsehair/50% polyethylene [50/50]).**

**Figure 2**




**Survival of *Listeria monocytogenes* on unwaxed tufted brushes with different filament materials over 14 days of storage.**

**Figure 3**