Practical application of superheated steam to harvesting, processing, and produce packing tools and equipment

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Summary

Superheated steam (SHS) represents an alternative to conventional sanitation strategies utilized in dry produce operations. There is limited data to support the efficacy of these conventional dry sanitation strategies in providing equivalent control over microbial removal or inactivation when compared to wet sanitation. Additionally, organic operations frequently rely on a water rinse step following sanitizer application to remove residues, which is not feasible using exclusively dry sanitation methods. SHS represents an energy and water efficient alternative to sanitation across food operations, but because it does not introduce moisture on equipment surfaces, its application to the treatment of dry produce handling surfaces is of growing interest. However, promising bench-scale findings must be evaluated in the practical application of SHS for successful implementation by the produce industry.

Objectives

1. Develop a model for superheated steam (SHS) efficacy as a function of surface features and treatment parameters.
2. Quantify the change to ambient relative humidity as a consequence of the extended use of SHS in indoor spaces as a function of steam flow rate, duration of treatment, size of enclosure, room ventilation, and air handling system.
3. Develop key performance indicators around SHS efficacy, implementation costs, and safety standards for produce industry adoption of this novel technology.

Methods

Portable, pilot-scale SHS units (roll-along and back-pack) were fabricated by a collaborating manufacturer and have been received by PI Snyder and Co-PI Bala. The bench-scale and pilot-scale units are shown in **Figure 1**. Material surfaces were fabricated for different surface thickness for stainless steel and concrete. Initial trials evaluating the thermal distribution across stainless steel surfaces have been conducted at ambient temperatures. Stainless steel surfaces of different thicknesses (0.018, 0.105, and 0.1875 inches) were evaluated with the nozzle of the SHS unit at three different distances from the surface. In addition, the safety standards and Occupational Health and Safety Administration (OSHA) compliance considerations were reviewed and summarized for both manually operated units.

Results to Date

OSHA standards specific to manual delivery of SHS do not exist; however, elements related to power tools and the general duty clause apply. An employee training slide deck (**Figure 2**) is available on the PI's website (https://blogs.cornell.edu/snyder/).
SHS temperature at the point of impingement on stainless steel surfaces varied from 320°C to 170°C depending on nozzle distance (1 to 3 inches). Initial results suggest that the surface reaches steady-state temperature in ~30 s to 2 min (**Figure 3**), depending on surface thickness and nozzle distance. There is a temperature gradient that drops by up to 200°C at 3 inches from the point of impingement. While the thicker stainless-steel material takes longer to reach its maximum temperature, it retains heat for a longer time (**Figure 4**).

Benefits to the Industry

Results from this project will be used in the development of data-driven resources that support industry decision-making around SHS implementation. These resources will allow the produce industry to comprehensively assess the anticipated performance of SHS technologies and take into consideration, not just efficacy, but important tradeoffs in commercial application. This allows individuals within the industry to identify the tradeoffs and drawbacks, in addition to the benefits and opportunities, associated with investment in a new sanitation tool. Consequently, individuals can use these resources to make informed decisions about sanitation tool acquisition for their business.

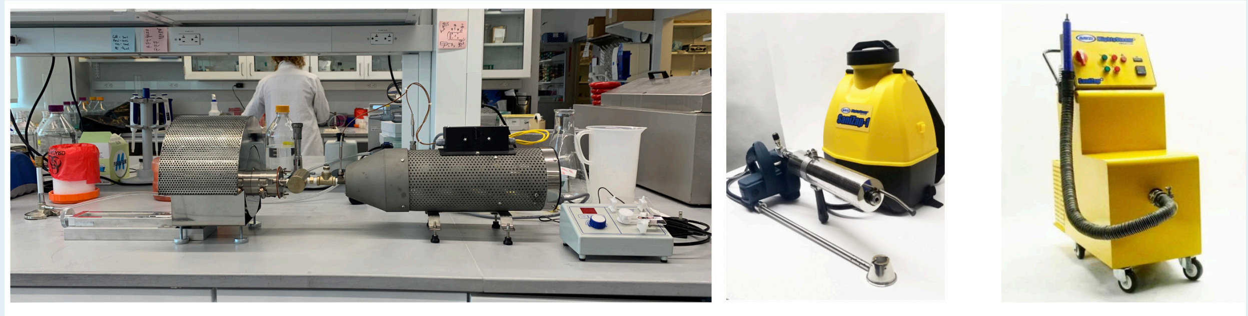

Figure 1. Bench-scale (left), back-pack (center), and roll-along (right) SHS units.

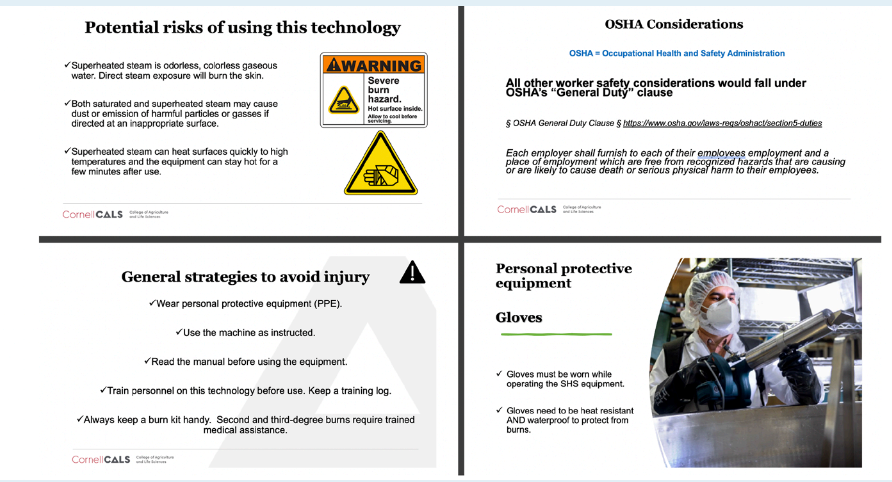

Figure 2. Examples from employee safety and worker compliance training.

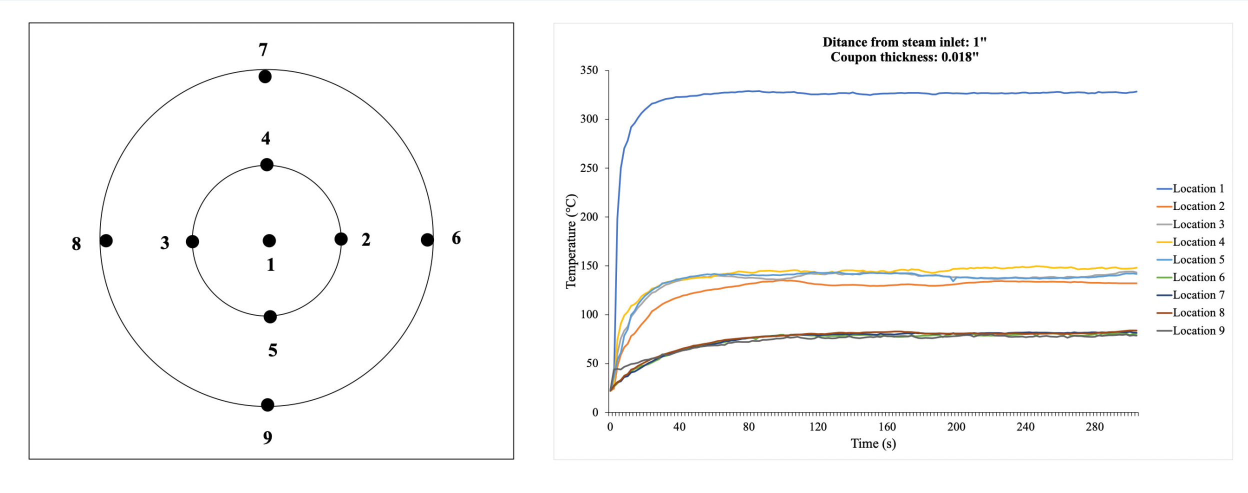

Figure 3. Thermocouple distribution across a coupon surface (L) and recorded temperature measurements (R).

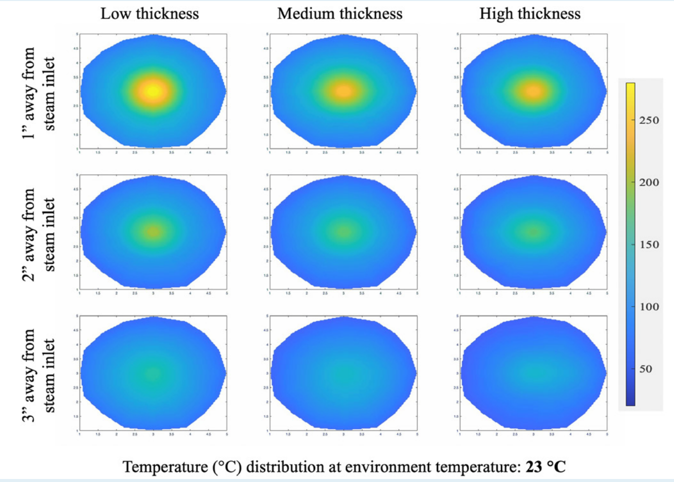

Figure 4. Temperature distribution across stainless steel surfaces as a function of surface thickness and nozzle distance using the SHS backpack unit.