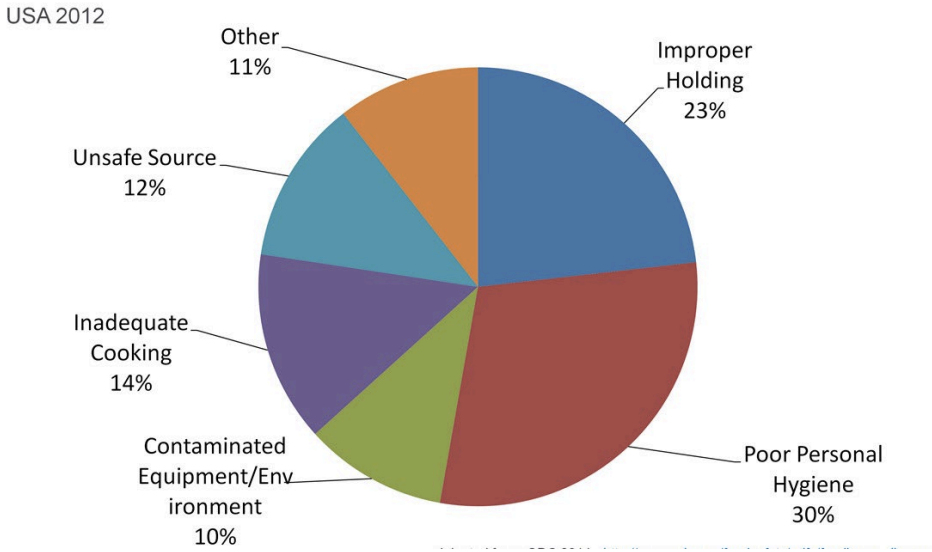
# THE RISK ASSESSMENT OF THE SANITATION PRACTICES OF MODIFIED WASHING MACHINES IN THE PROCESSING OF LEAFY GREENS.

**Pragathi Kamarasu, Ph.D.**

University of Massachusetts Amherst


WHO

## CDC Contributing Factors to Foodborne Illness




ECOLAB

# INTRODUCTION: *LISTERIA MONOCYTOGENES*

**LISTERIOSIS CAUSED BY *LISTERIA MONOCYTOGENES* OUTBREAKS LINKED TO THESE FOOD GROUPS:**

Raw fruits and vegetables

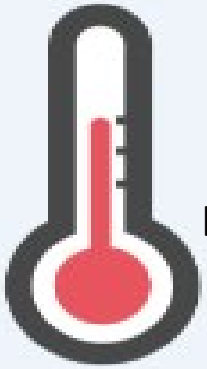
Raw milk and products

Deli meat and soft cheeses

Enoki mushrooms

**PEOPLE AT HIGH RISK**

**ELDERLY** **PREGNANT WOMEN** **CHILDREN**



**LISTERIA IS A RESILIENT BACTERIUM**

**It can survive at refrigeration temperature (psychotropic)**

**ENVIRONMENTALLY UBIQUITOUS FROM FARM TO FORK**


- **Third leading cause of death from foodborne illness (around 260 dead per year in U.S.A)**

# INTRODUCTION: *LISTERIA MONOCYTOGENES* OUTBREAKS

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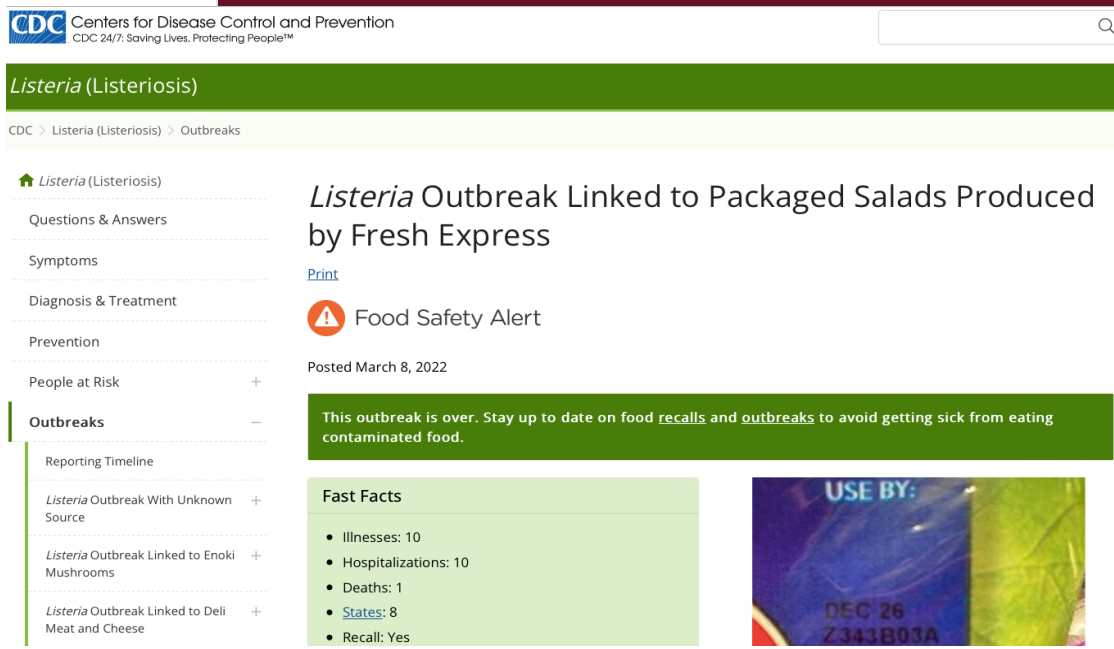
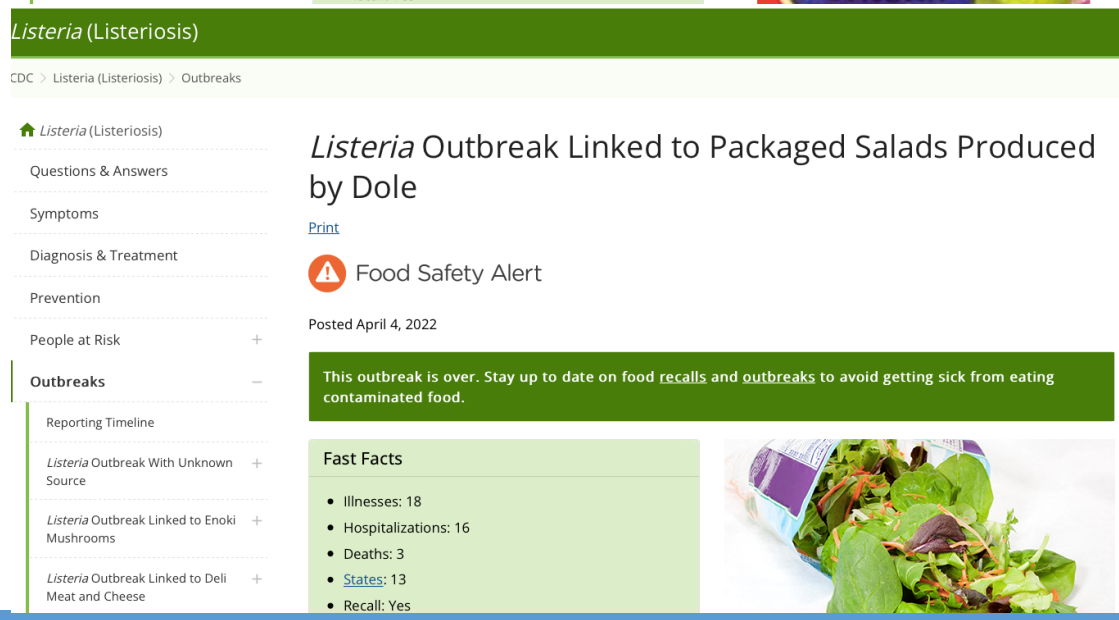
CDC Listeriosis outbreaks:

- Packaged salads by Fresh Express
- Packaged salads by Dole
- Cantaloupes by Jensen Farms
- Prepackaged caramel apples



# INTRODUCTION: POST HARVEST HANDLING OF PRODUCE

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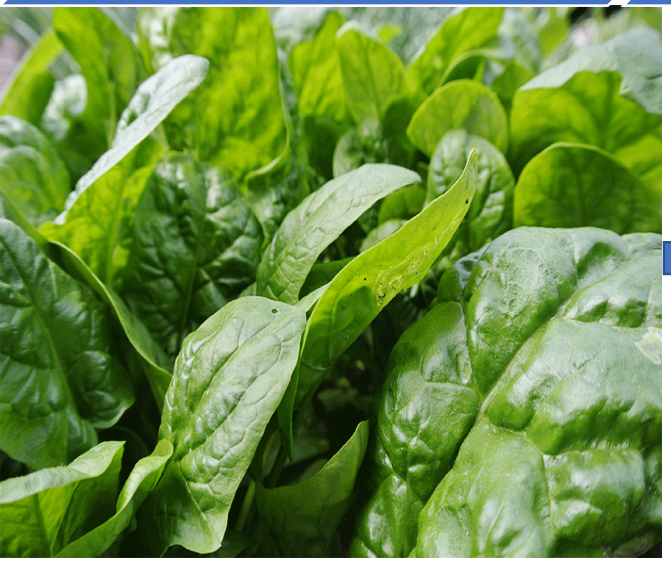
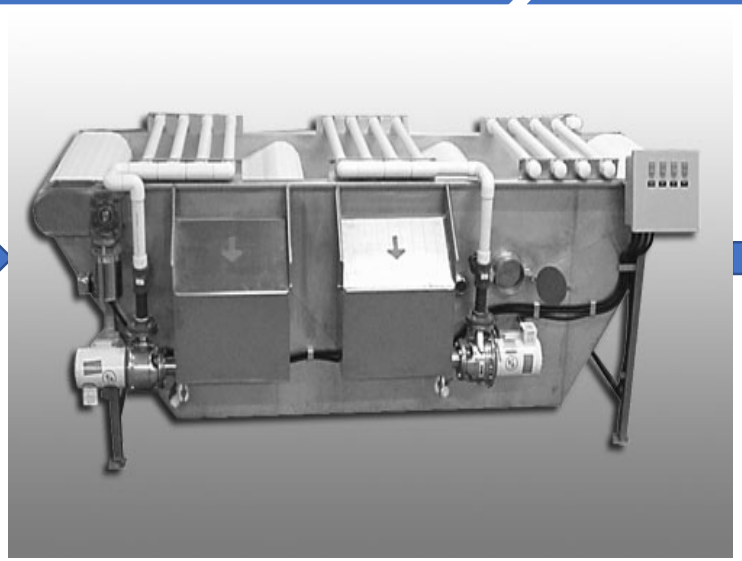
HARVESTING → TRIPLE WASH → DRYING → PACKAGING





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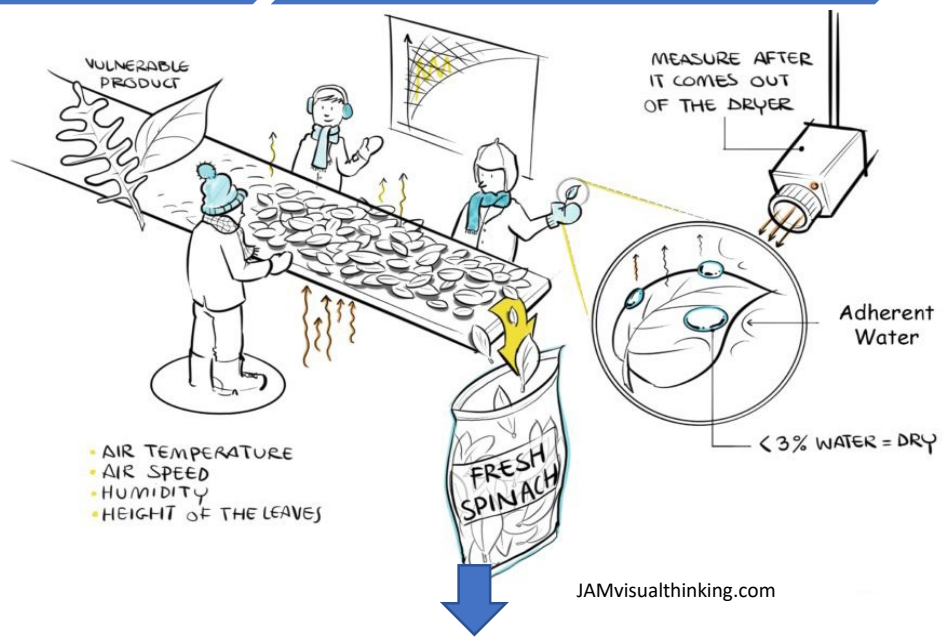


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- More reliable as FDA recommended SSOPs followed.
- Less probability for improper handling as human error is reduced.
- Controlled environmental conditions.


Food-safety.com

# HYPOTHESIS: WHAT IS THE RISK IN THE USE OF RETROFITTED WASHING MACHINE FOR SPIN-DRYING?

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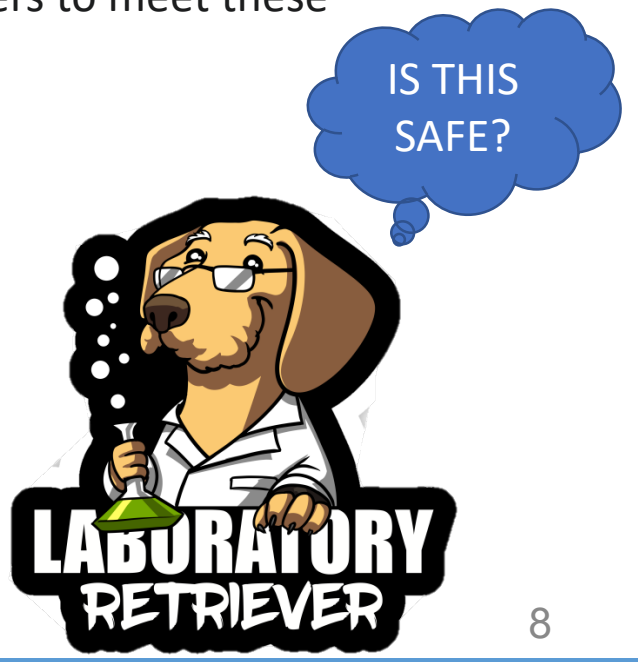
- ✓ This practice is cost efficient, user-friendly and there is a high production value.
- ✓ However, the main concern in retrofitted washing machine is that it must be drilled open to reach the third layer. This makes it difficult to access all parts of the machine to aid in sanitation.
- ✓ Due to the recently implemented Food Safety Modernization Act (FSMA) and Produce Safety Rule (PSR) that states specific sanitary regulatory conditions during postharvest handling there is a need for producers to meet these requirements.



# OBJECTIVES:

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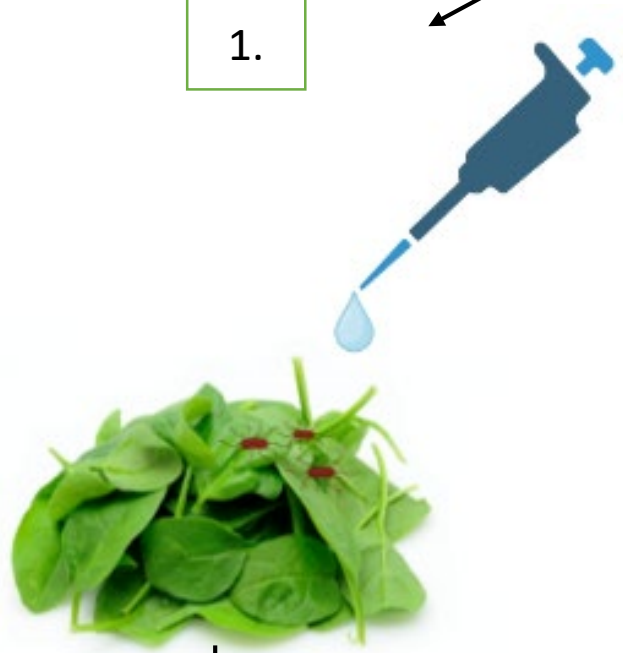
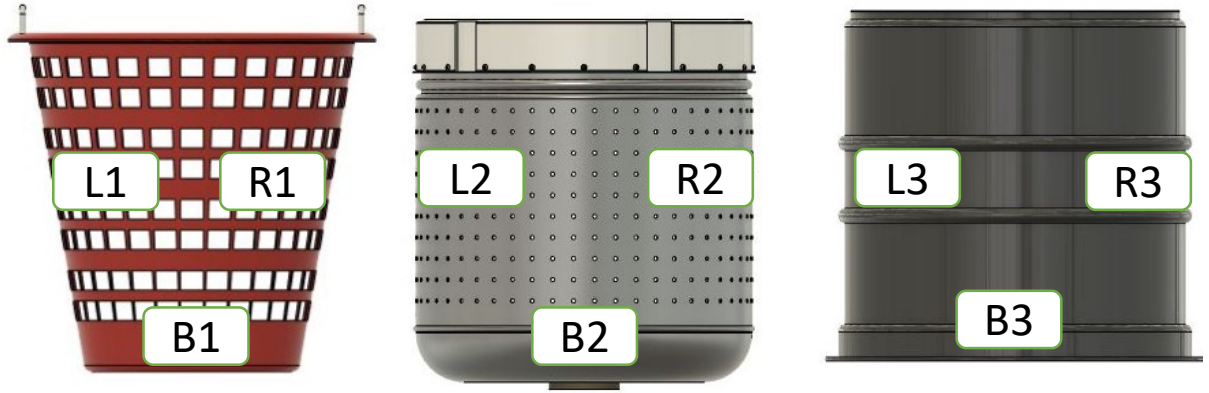
Spinach surface and contact points of the machine were inoculated with *Listeria innocua* (Gram-positive bacterium, non-pathogenic surrogate for *Listeria monocytogenes*) of in a low ($10^6$ CFU/ml) and high ($10^9$ CFU/ml) microbial load.

1.



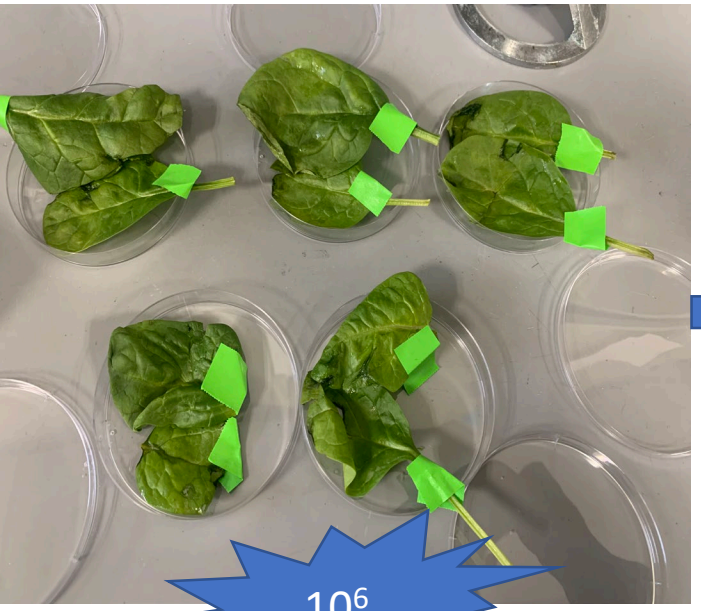
TRANSFER TO MACHINE

2.

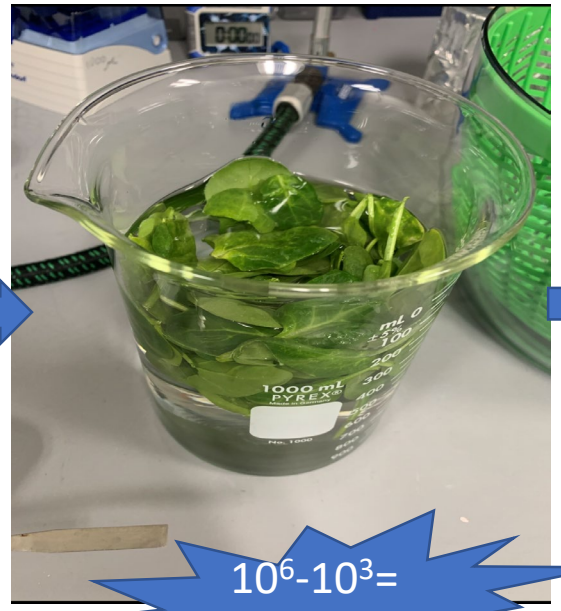



TRANSFER TO NON-INOCULATED SPINACH

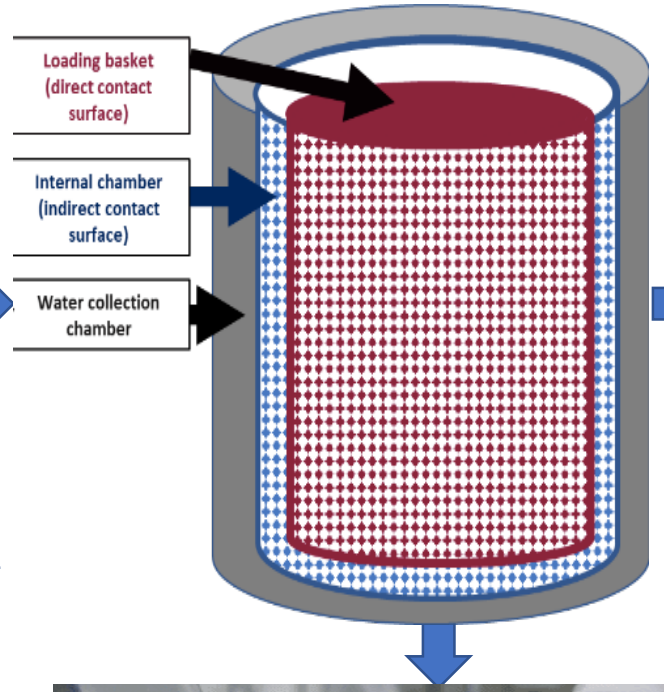
# PROCEDURE: MICROBIAL RECOVERY IN DIFFERENT STAGES OF POST HARVEST HANDLING

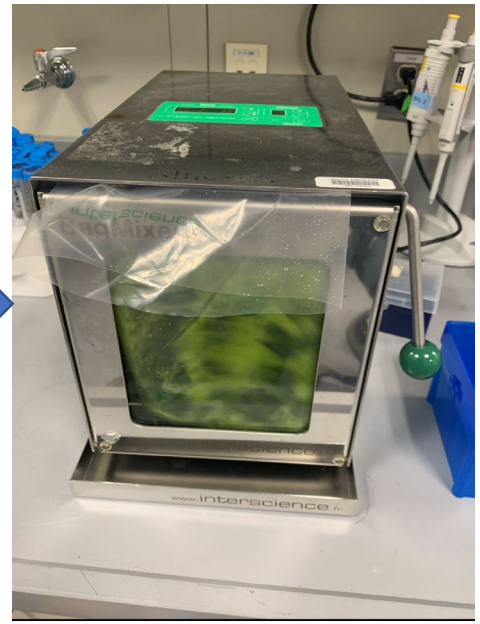


$10^6$

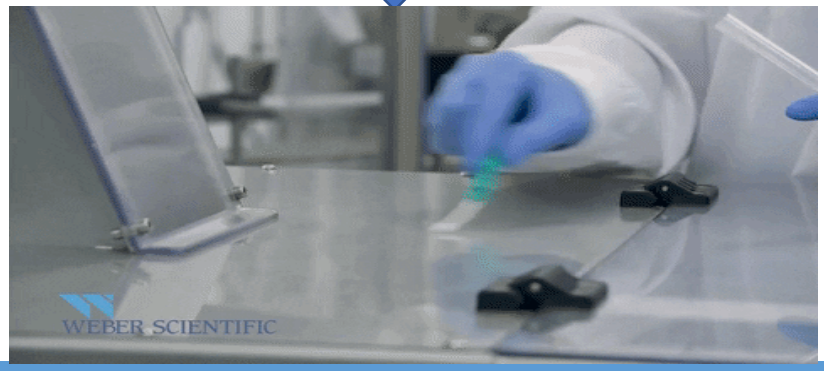


$10^6$-$10^3$= $10^3$



- ATP and Microbial swabs.



**OBJECTIVE 1:**

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- ✓ What happens when you introduce pre inoculated spinach (low and high microbial load ($10^6$ CFU/ml), ($10^9$ CFU/ml)) into the retrofitted machine for spin-drying?

# RESULT: INOCULATED SPINACH SPIN-DRYING

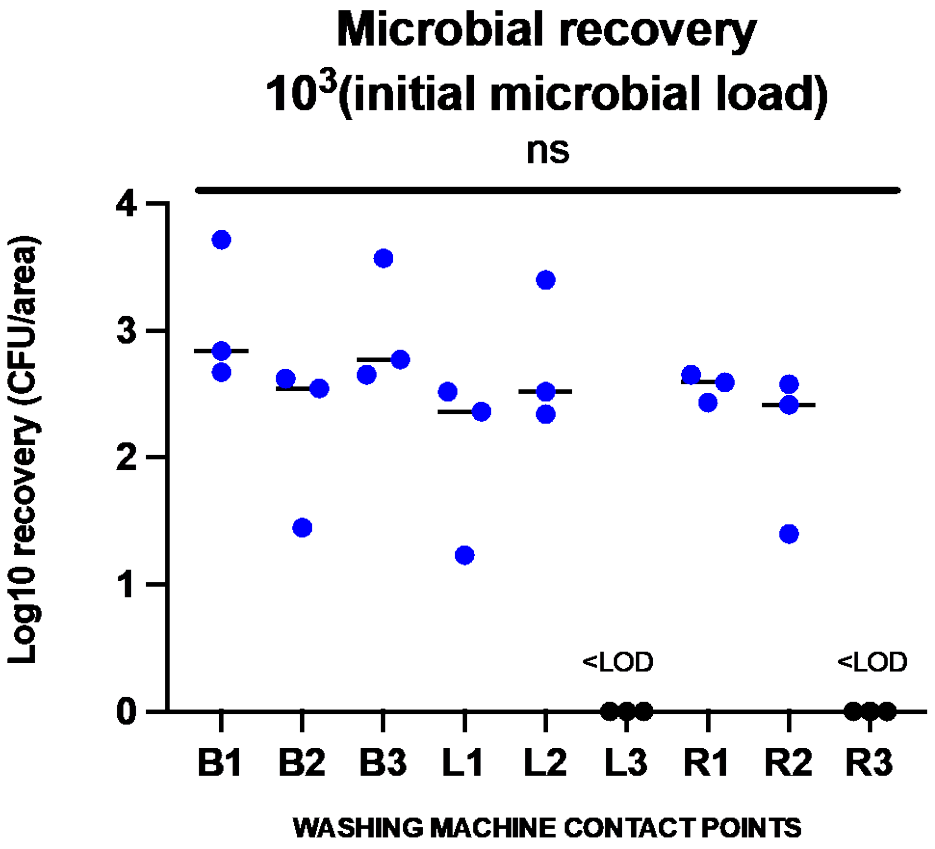
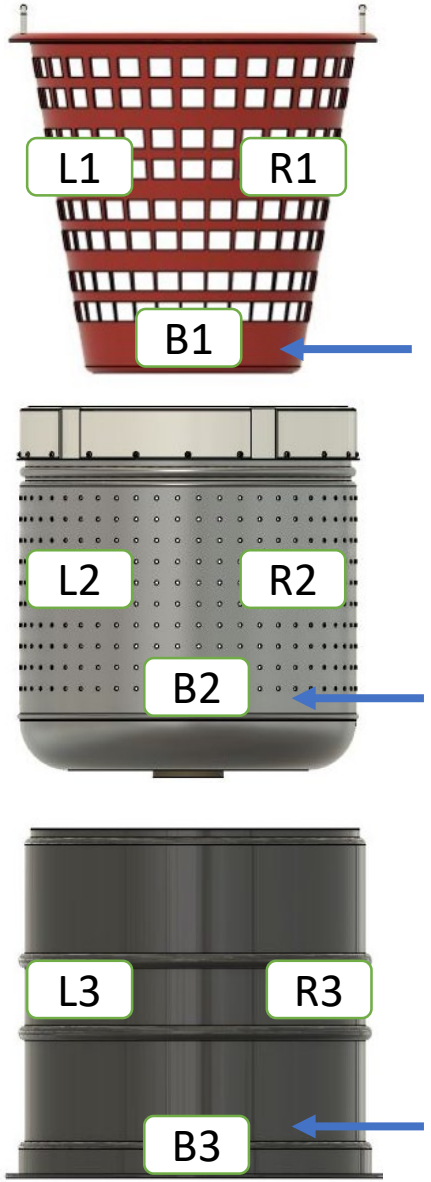



Figure 1: Microbial recovery from all the contact points of the machine for an initial microbial load of $10^3$ CFU/ml of *Listeria innocua*

**Nearly complete recovery from the contact points!!**



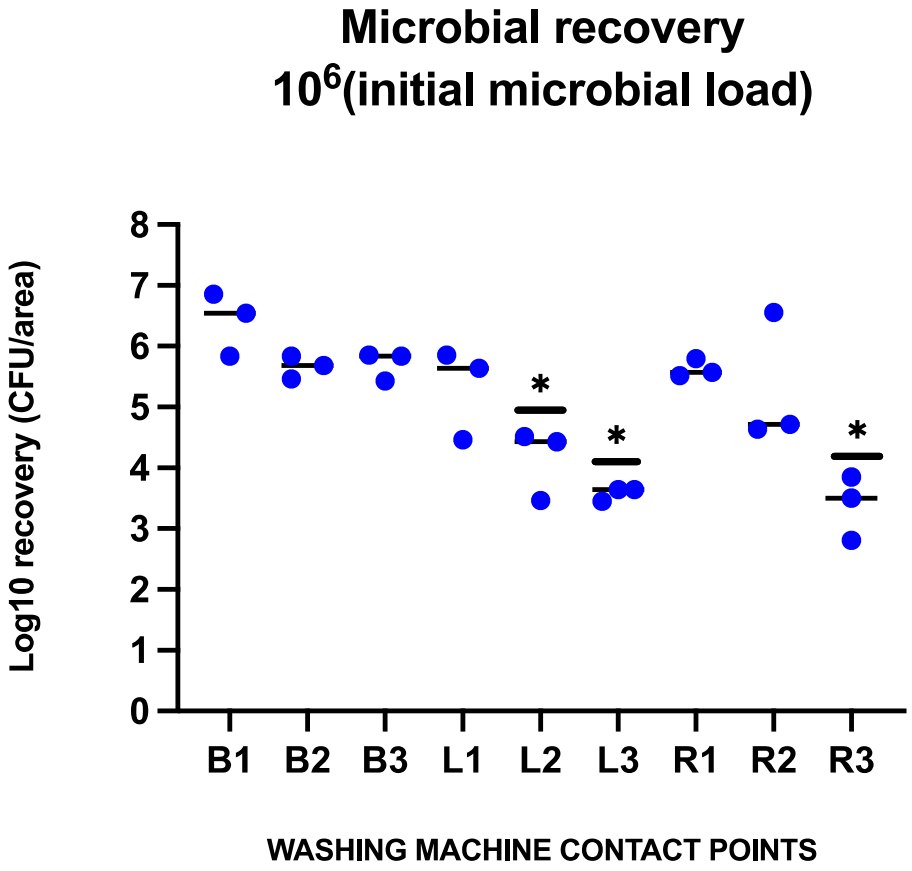




Figure 2: Microbial recovery from all the contact points of the machine for an initial microbial load of $10^6$ CFU/ml of *Listeria innocua*

**OBJECTIVE 2:**

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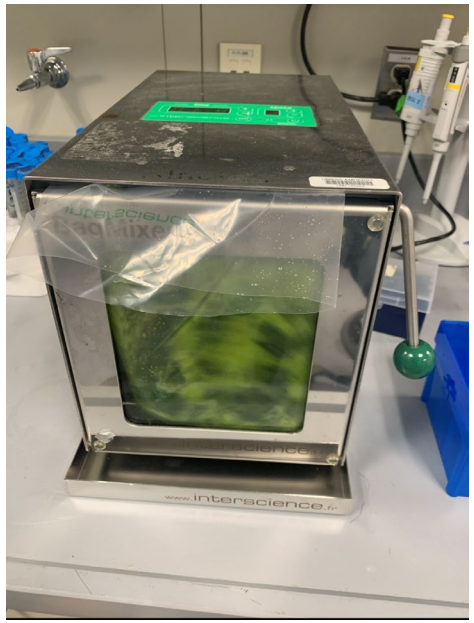
- ✓ What happens when you introduce fresh spinach into this contaminated machine?

# RESULT: MICROBIAL TRANSFER TO NON-INOCULATED PRODUCE





MICROBIAL ENUMERATION

- ✓ A concern for *Listeria* as they are psychotropic, hence they can grow when stored post-harvest at refrigeration temperatures.

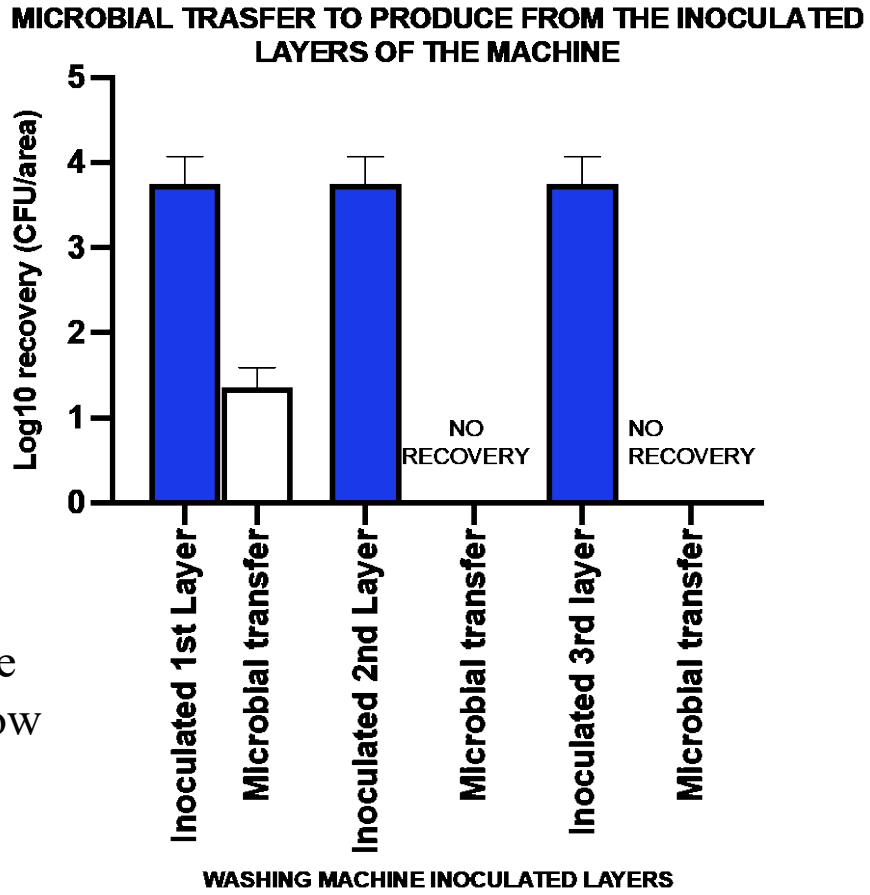



Figure 3: Microbial transfer to fresh spinach from contaminated layers of the machine.

**HYPOTHESIS:**

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✓ A clear presence of risk has been established.

What are the mitigation strategies to reduce this risk?

1.

- Investigation of FDA recommended cleaning practices.

2.

- Investigation of FDA recommended sanitation practices.

3.

- Investigation of on-site sanitation indicators such as ATP Lumitester machines.

# RISK REDUCTION MITIGATION STRATERGY: CLEANING APPLICATIONS

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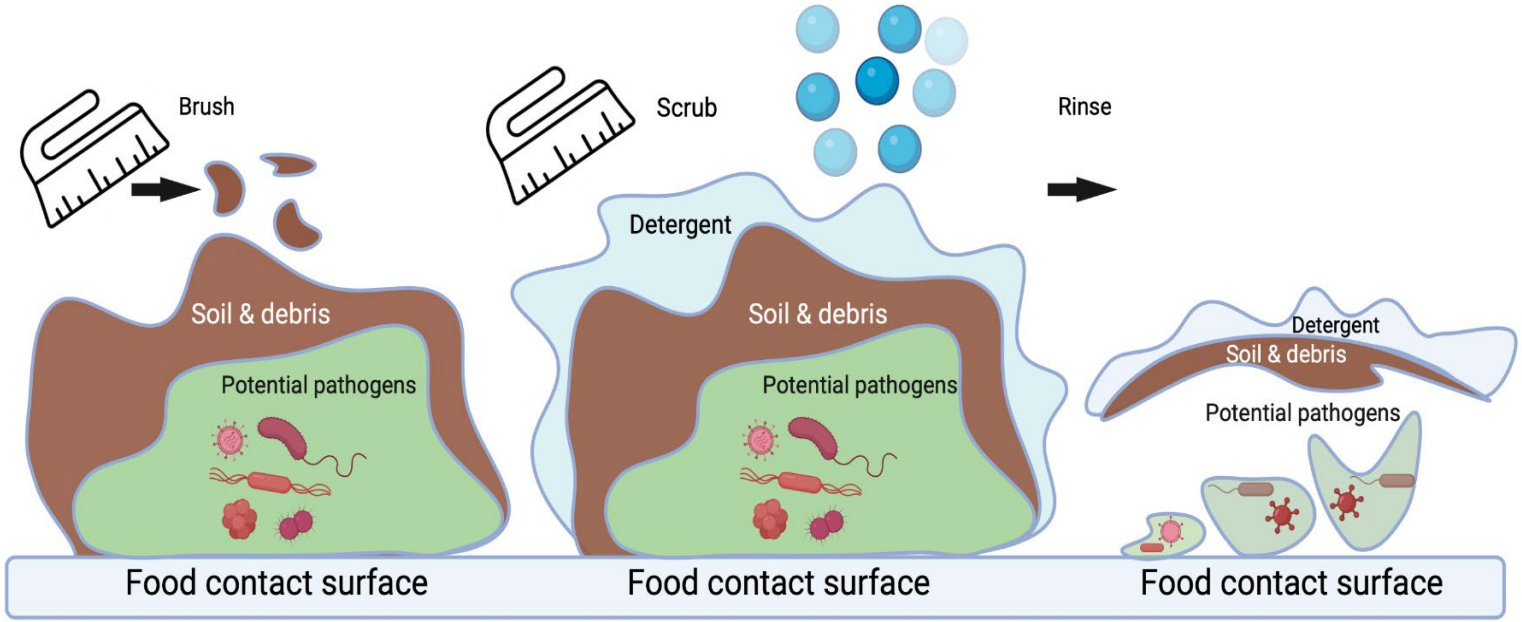
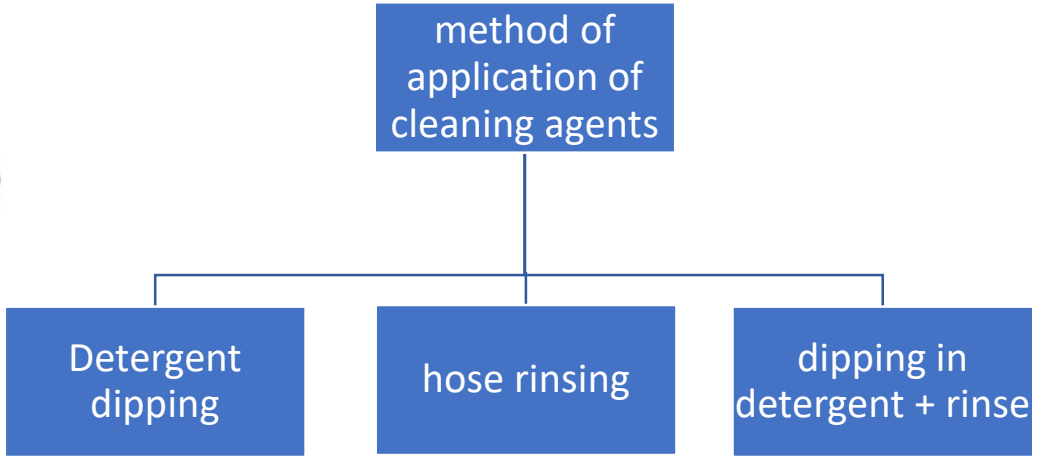
1. 2. 3.



# RISK REDUCTION MITIGATION STRATERGY: SANITATION PRACTICES

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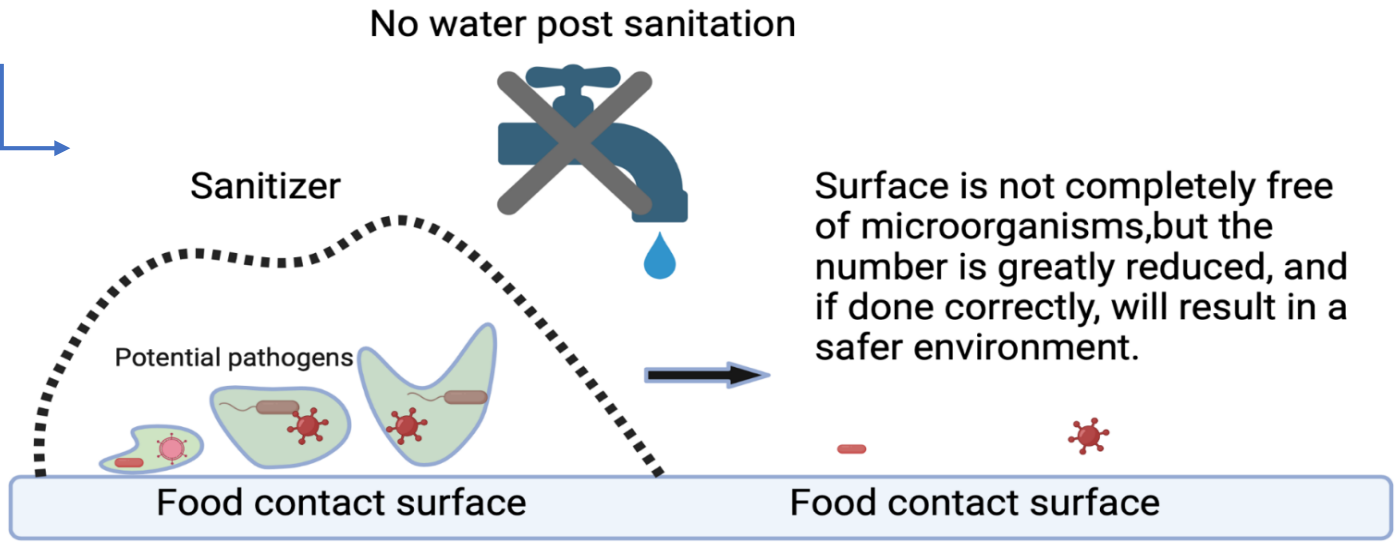
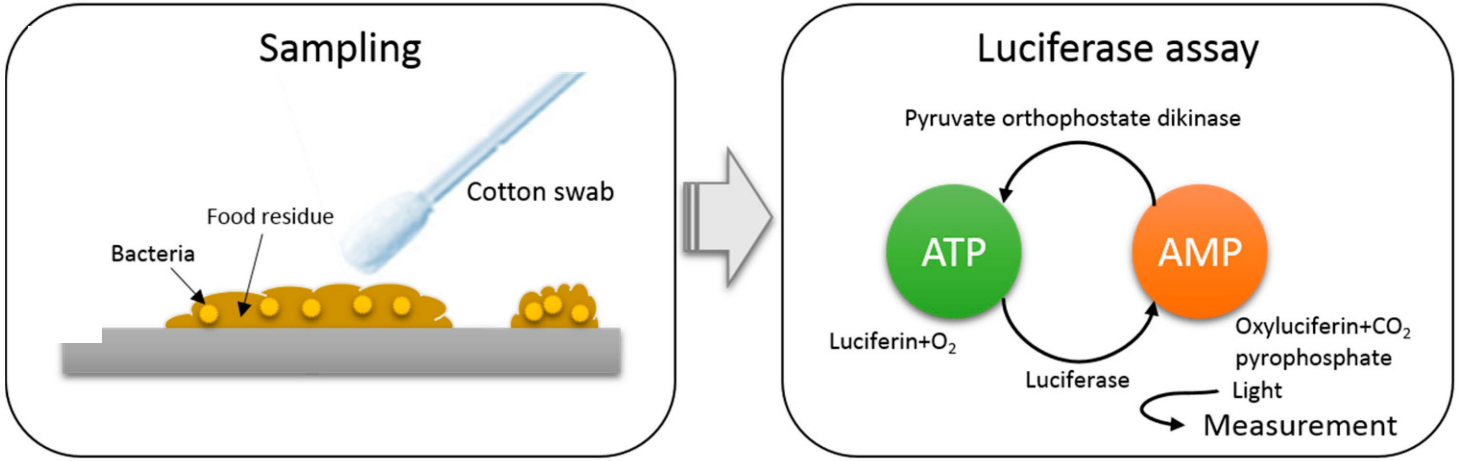
- Clorox® (7.03% available Sodium hypochlorite): 200 ppm free chlorine- wet for 5 minutes and allowed to air dry.
- SaniDate 15® (15% available Peracetic acid): 110 ppm free PAA- wet for 10 minutes and allowed to air dry.



# RISK REDUCTION MITIGATION STRATERGY: ON-SITE SANITATION INDICATOR ATP LUMITESTER MACHINES

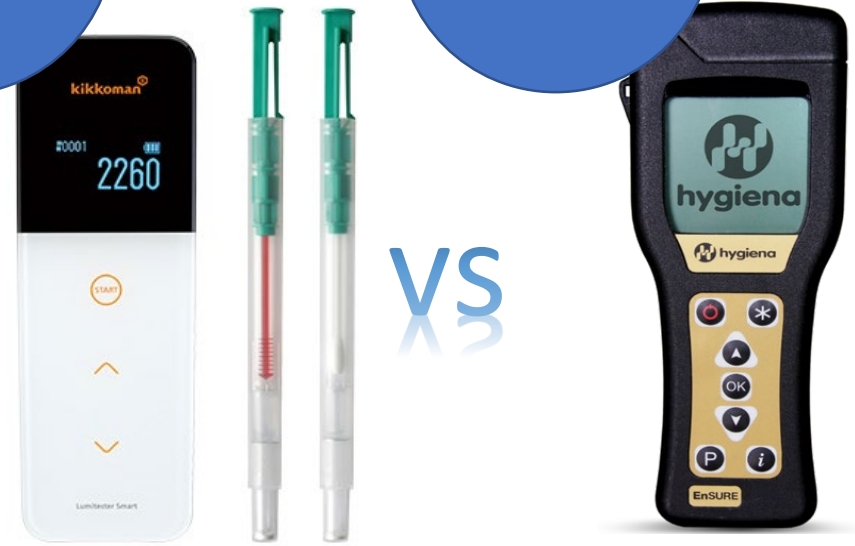





- Most commonly used sanitation indicator
- Good repeatability/reproducibility
- Easy to use
- Rapid
- Cheap
- Foolproof/recordable/tamperproof
- Results can be used in trend analysis

Kikkoman Lumitester Smart machine and Lucipac A3 swabs

Hygiena standard Lumitester machine and ATP swabs



# RESULT: MICROBIAL RECOVERY POST SPIN DRYING CLEANING AND SANITATION

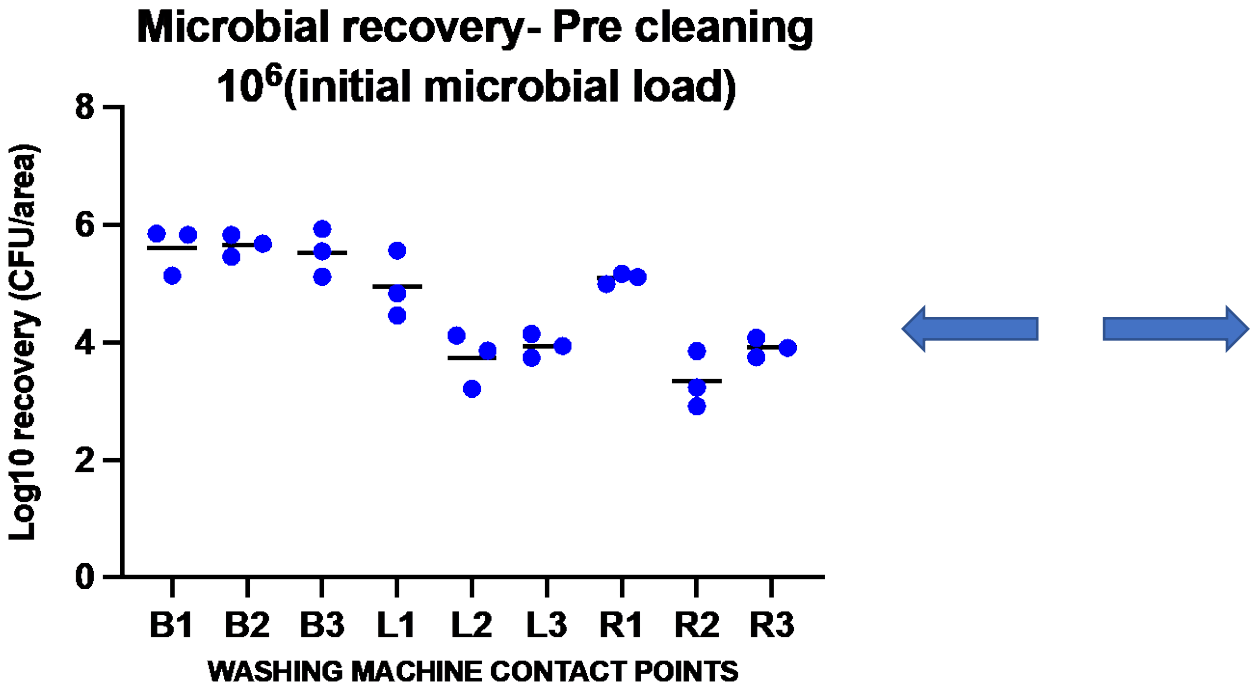



Figure 4: Microbial recovery from all the contact points of the machine for an initial microbial load of $10^6$ CFU/ml of *Listeria innocua* pre cleaning

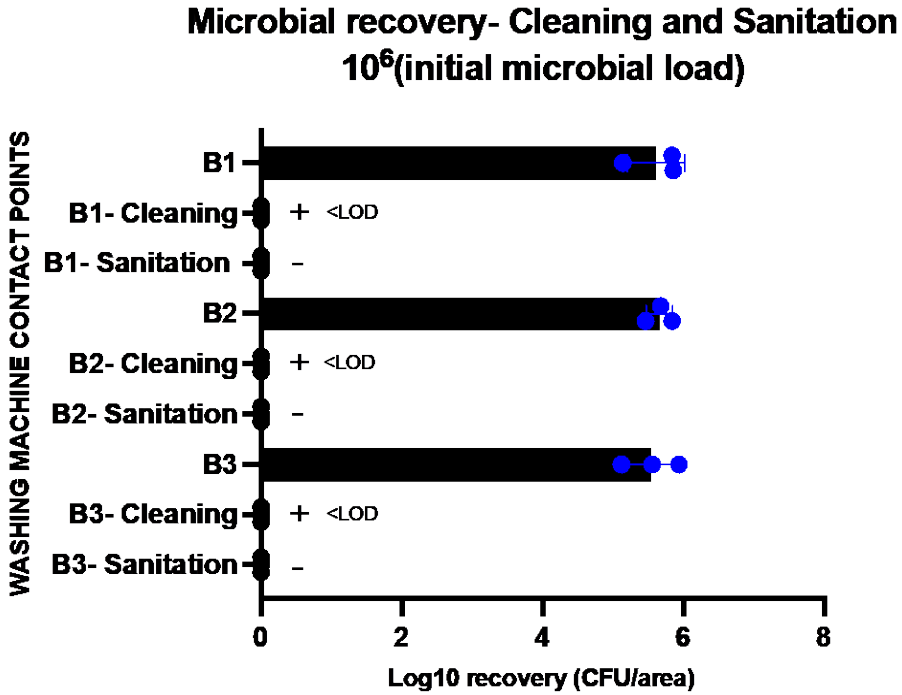
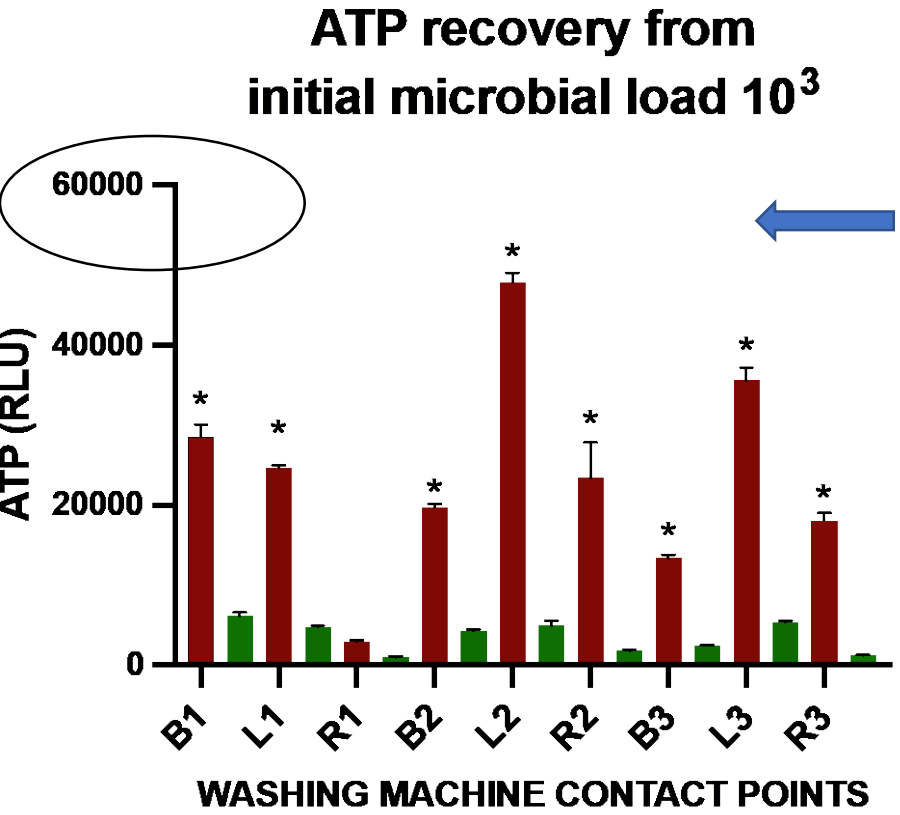
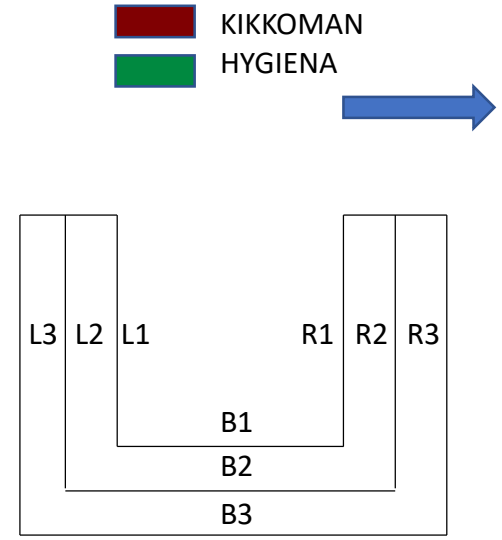


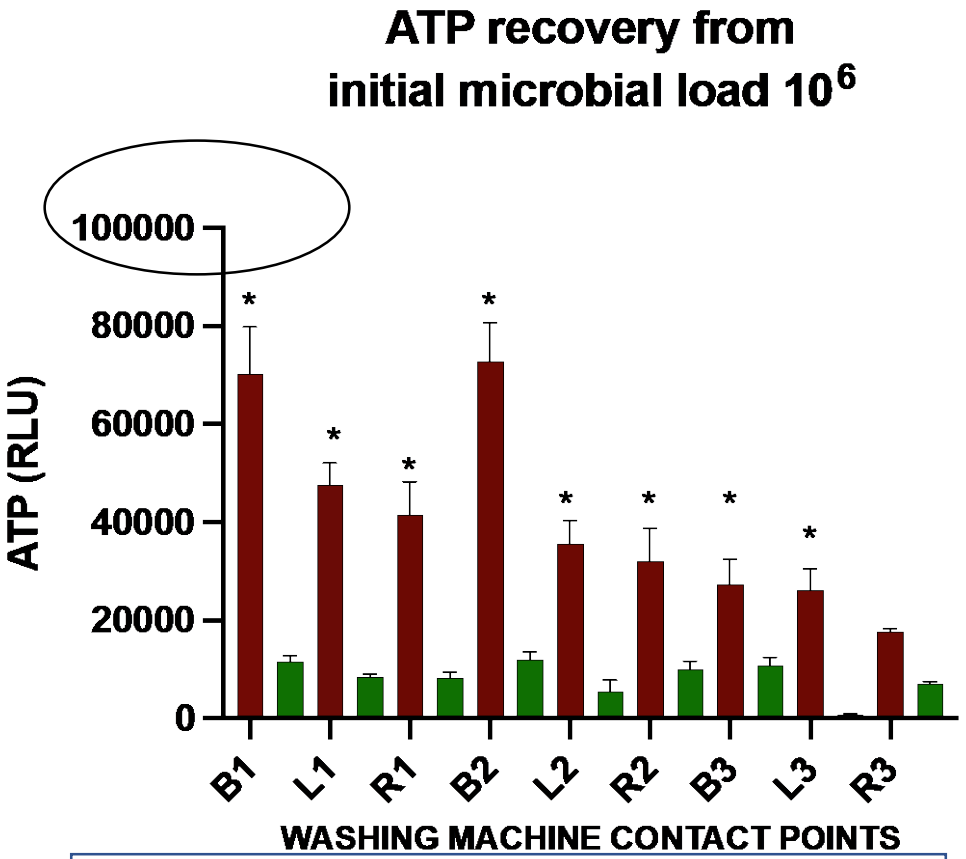

Figure 5: Microbial recovery from the contact points B1,B2 and B3 after spin drying, post cleaning and post sanitation; LOD- 25 CFU/ml

- No statistical difference in the efficiency of both PAA and Chlorine sanitizers.

# RESULT: ATP RECOVERY POST SPIN DRYING FOR HIGH AND LOW INOCULATION LOAD




KIKKOMAN RANGE: 200- 40,000 RLU
HYGIENA RANGE: 100- 7000 RLU

Figure 6: ATP measurement from all the contact points of the machine for an initial microbial load of $10^3$ CFU/ml of *Listeria innocua*

KIKKOMAN RANGE: 17000- 80,000 RLU
HYGIENA RANGE: 600- 12000 RLU

Figure 7: ATP measurement from all the contact points of the machine for an initial microbial load of $10^6$ CFU/ml of *Listeria innocua*

# RESULT: ATP RECOVERY POST CLEANING- LUMITESTER MACHINE COMPARITIVE STUDY

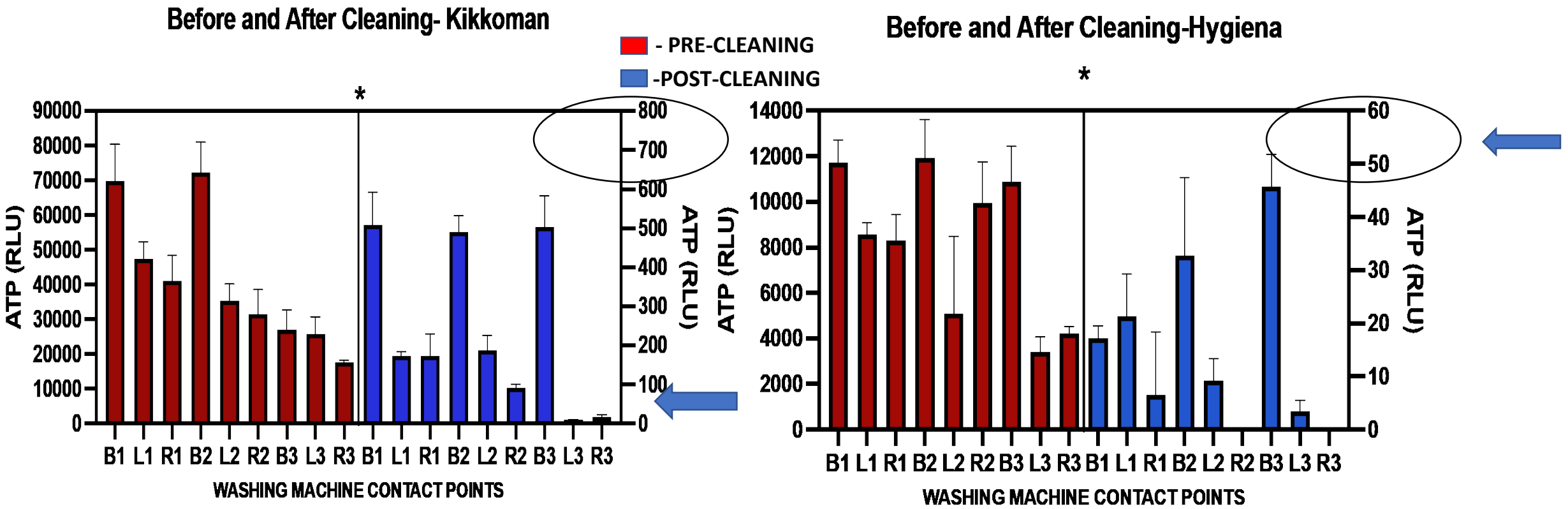



Figure 8;9: ATP (RLU) recovery from all the contact points of the machine pre and post application of cleaning practices when measured with Kikkoman (Left); ATP (RLU) recovery from all the contact points of the machine pre and post application of cleaning practices when measured with Hygiena (Right).

Pass limit for a clean food contact surface is 150 RLU. This was achieved when measured with Hygiena Lumitester machine. However, this pass limit was only met in the contact points R2, L3, and R3 when measured with Kikkoman machine.

# RESULT: ATP RECOVERY POST CLEANING AND SANITATION

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| Type of sanitizer | ATP recovered post spin drying (RLU) | ATP recovered post cleaning (RLU) | ATP recovered post sanitizing (RLU) |
|---|---|---|---|
| Hygiena | • 8000±8500 RLU | 25±35 RLU → | • Chlorine- 31±44 RLU<br>• Peroxy acetic acid- 10±14 RLU |
| Kikkoman A3 | • 18000-80000 RLU | 9-600 RLU → | • Chlorine- 231±317 RLU<br>• Peroxy acetic acid- 310±410 RLU |

TABLE 1: ATP recovery range from the various contact points post spin drying; post application of cleaning methods and post application of chlorine and peroxy acetic acid sanitizers when measuring with Hygiena and Kikkoman Lumitester machines.

# CONCLUSIONS:



The use of retrofitted washing machines is a user-friendly, cost effective and efficient process.

The results suggest that the application of proper cleaning and sanitation can be efficient at mitigating the risk.

The results suggest that the Kikkoman machine was highly sensitive when compared to Hygiena. The results suggest that specific pass limit must be applied based on the type of Lumitester machine used.

# ACKNOWLEDGEMENT:




- I would like to thank all my professors, collaborators and fellow lab members for supporting my research.

MDAR
MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

CAPITAL AREA FOOD PROTECTION ASSOCIATION

kikkoman
Kikkoman Biochemifa Company

MOORE LAB:
Dr Matthew D Moore, Assistant Professor
Cassandra Suther, Anand Soorneedi, Sloane Stoufer, Minji Kim, Christina Wormald, Nikhita Venigalla, Bozhong Guan, Tainyuan Zhou

KINCHLA LAB:
Amanda Kinchla, Associate Extension Professor
Julia Fukaba, Mariana De Oliveira