Microbiological Sampling and Testing Approaches for Food Safety Management &

Role of Hygiene Indicators

KATHERINE M.J. SWANSON, PH.D.

KMJ Swanson Food Safety, Inc.

Mendota Heights, MN USA

Discussion Topics

- Definition of indicators
- Limitations of indicators
- Examples of indicator tests
- Use of indicator data

Objectives of Testing in Food Processing

- Satisfy customer and regulatory requirements
- Verify process control
- Identify potential issues BEFORE they become real problems

Definition – Utility Tests

- Provide information about:
  - General contamination
  - Potentially reduced shelf life
  - Incipient spoilage
- Should be relevant to food; e.g.,
  - Fermented foods may have high aerobic colony counts, thus are not relevant
  - Pasteurized product should have low aerobic colony counts

- Examples
  - Aerobic colony count
  - Direct microscopic count
  - Yeast and mold count
  - Pseudomonads in aerobically stored meat
  - Lactobacilli in mayonnaise

Definitions – Indicator Tests

- Provide information as a measure of GHP or process control

- **May** indicate the potential for presence of pathogen microorganisms

- Examples
  - Coliforms
  - Enterobacteriaceae
  - *E. coli*
  - *Listeria*-like microorganisms

Limitations of Indicator Tests

Limitations of Indicators

- Relationship between pathogen and indicators is NOT universal
  - Influenced by process and product
- May indicate conditions that allow presence of pathogens
  - Little correlation with **actual** presence

- Examples: Enterobacteriaceae or coliforms
  - Useful for milk pasteurization – should be <10/g
  - Useful for blanched vegetables – may be found a low levels (<100/g), but not always absent
  - Limited or no use for fresh produce – naturally present, sometimes at high levels because there is no kill step

Limitations of Indicators

- Relationship between a pathogen and indicator influenced by product and process → NOT universal

- May indicate conditions that allow presence of pathogens

- Enterobacteriaceae or coliforms examples:

Product	Utility	Typical levels
Pasteurized milk	Useful	<10/g
Blanched vegetables	Useful, but not always absent	<100/g
Fresh produce	Limited or no use	Naturally present

Examples of Indicator Tests

From ICMSF (2011) Microorganisms in Foods 8: Use of Data for Assessing Process Control and Product Acceptance

Examples of Indicators – End Product

Product (relative importance)	Indicator or Utility	Sampling Plan and Limits			
		n	c	m	M
Frozen vegetables, blanched (medium)	Aerobic colony count	5	2	10^4/g	10^5/g
	Enterobacteriaceae	5	2	10^1/g	10^2/g
	E. coli	5	2	$<10^1$/g	-
Fresh-cut RTE vegetables (medium)	*E. coli*	5	1	10^1/g	10^2/g

Examples of Indicators – End Product

Product (relative importance)	Indicator or Utility	Sampling Plan and Limits			
		n	c	m	M
Cooked meat (medium)	Aerobic colony count	5	2	10^4/g	10^5/g
	E. coli	5	2	10^1/g	10^2/g
	S. aureus	5	1	10^2/g	10^3/g
Dry milk powder (high)	Aerobic colony count	5	2	10^4/g	10^5/g
	Enterobacteriaceae	5	2	<3/g	9.8/g
Water for processing	Coliforms	1	0	0/100mL	-

Example: Dry Milk Powder

Relative Importance		Test	Sampling Plan and Limits			
In-process	High	Enterobacteriaceae	Same as end product			
	High	*Salmonella*	Absent in any samples			
Processing environment	High	Enterobacteriaceae	$\leq$100 CFU/g or sample			
	High	*Salmonella*	Absent in any samples			
End product			n	c	m	M
	High	Aerobic colony count	5	2	10^4/g	10^5/g
	High	Enterobacteriaceae	5	2	<3/g	9.8/g
	Low*	*Salmonella*	20$\times$25g	0	0	-
	unless other tests indicate a problem					

Using Indicator Data

Quantitative Data Can Be More Informative Than Qualitative Data

Presence/Absence

Quantative

Positive

Negative

Lot Number

Lot Number

Log (CFU/g)

Trend Analysis Can Inform Process Control
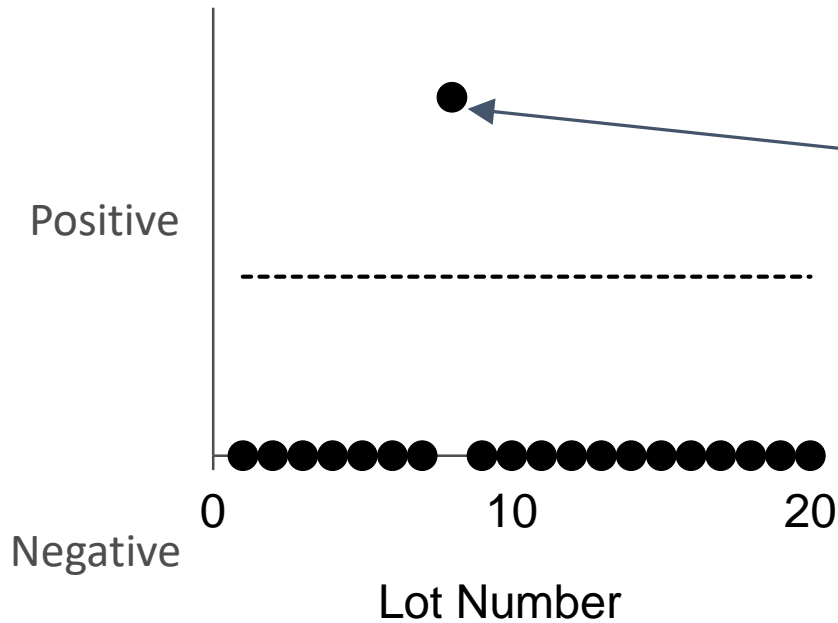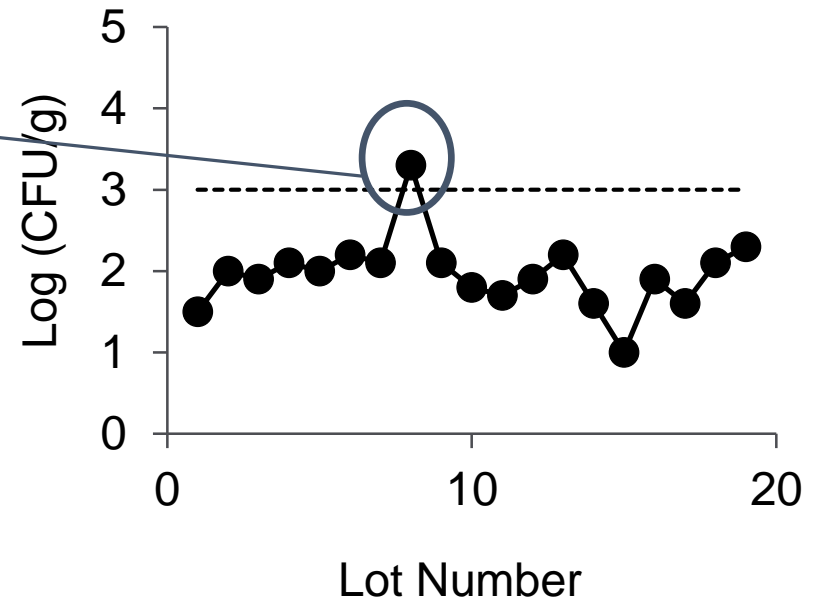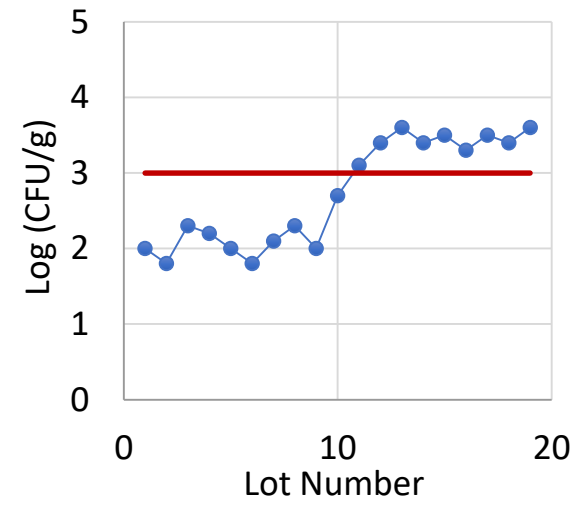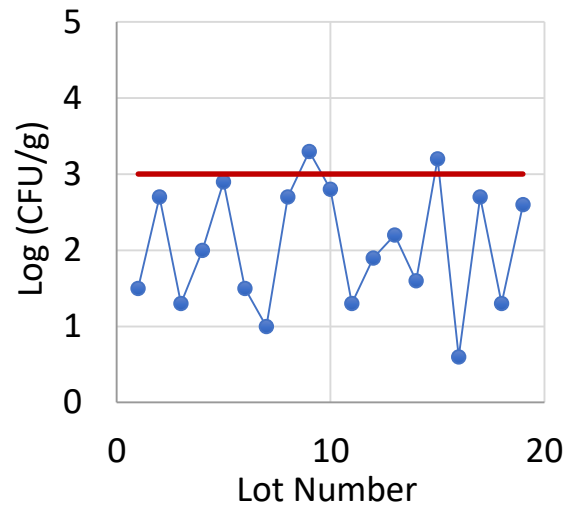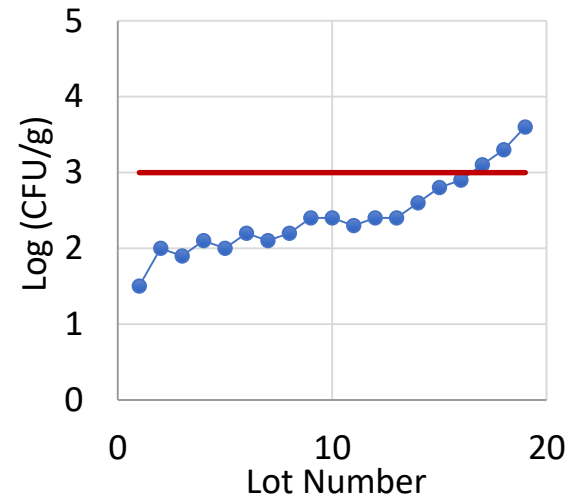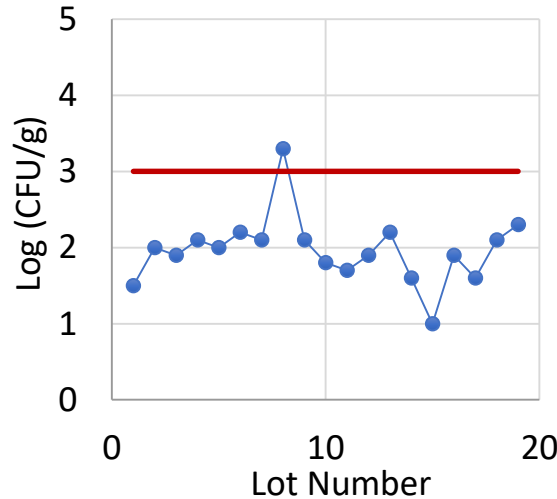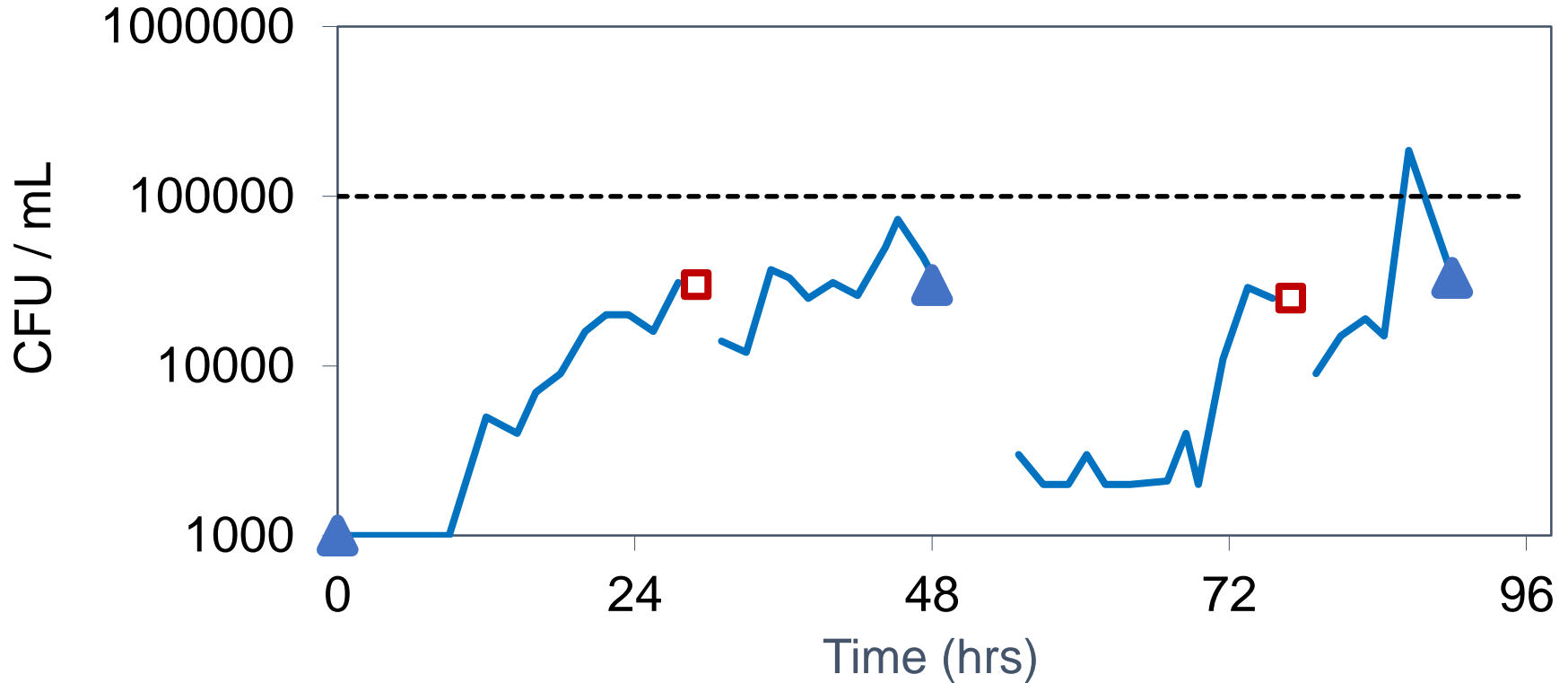

From ICMSF (2002, 2018) *Microorganisms in Foods 7: Microbiological Testing in Food Safety Management*

Aerobic Colony Count in Blanched Vegetable Flume Water
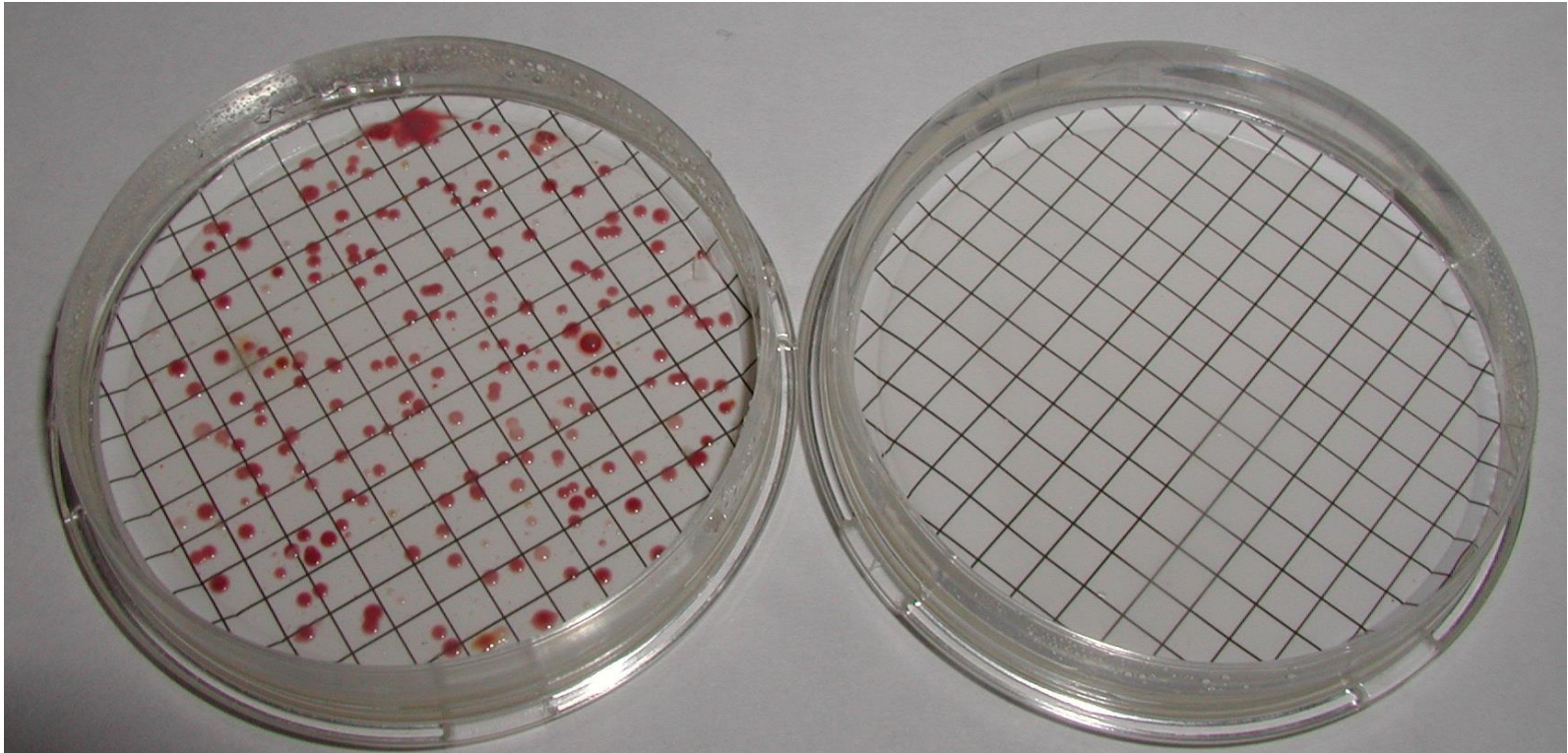
IMPACT OF SANITATION VERSUS WATER RINSE

Source: Swanson data

Membrane Filter Coliform Count
100 mL OF SANITIZER FROM CENTRAL SANITIZER HOSE

Before cleaning nozzle and hose

After cleaning nozzle and hose

Source: Boufford personal communication

Concluding Remarks

- Indicator tests:
  - Provide a practical and useful tool for verification in many food production environments
  - Can provide actionable information to direct corrective action efforts in a timely manner
  - May be coupled with pathogen testing, especially when unusual results are detected
- Application varies by product, location, history, and other factors
- Trend analysis maximizes the benefit of indicator testing.