Summary & PowerPoint

Addressing Emerging Concerns Related to Safety of Wheat-Based Products

Summary to follow.

Learning Objectives

Presenter
Andréia Bianchini, University of Nebraska - Lincoln

Presentation Time
Monday, February 25, 2019
2:10 pm - 2:45 pm

Session
Breakout 3

Microbiological Challenges and Milling Interventions to Address Emerging Concerns Related to the Safety of Wheat-based Products

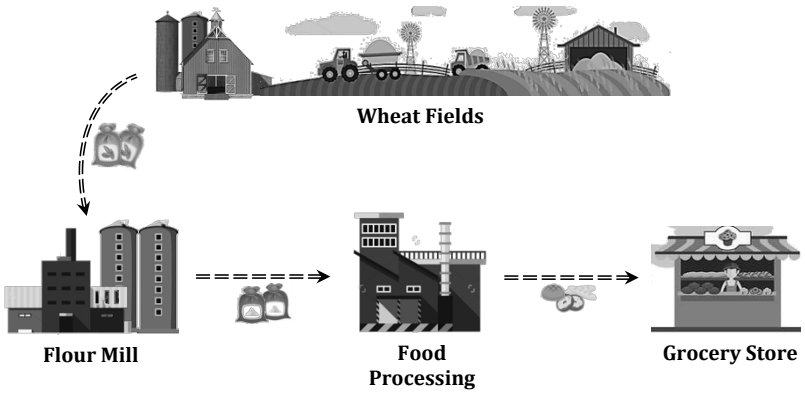
Dr. Andreia Bianchini
Food Science and Technology Department
The Food Processing Center
University of Nebraska - Lincoln

N 150
IN OUR GRIT, OUR GLORY.

The Food Processing Center

Grain Safety Research Group

Field-to-Table Continuum

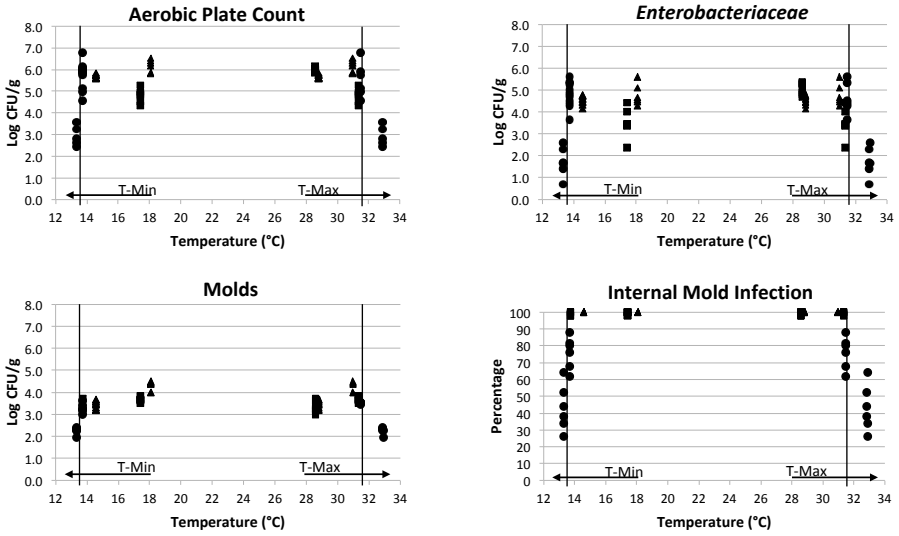


Microbiological Challenges

Fluctuation in microbial populations:

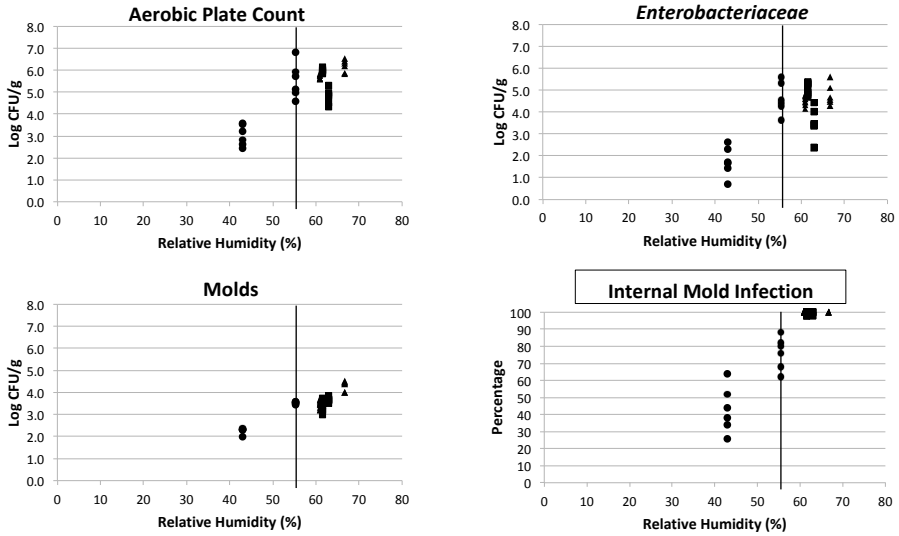
- ✓ Production **practices**
- ✓ **Method** of harvesting
- ✓ **Meteorological conditions**
- ✓ Transportation
- ✓ **Storage conditions**

Effect of Temperature after Flowering



* Microbial load (● Panhandle, ▪ South Central, ▲ Southeast) in response to average the average low and high temperature levels (T-Min and T-Max) prevailing from flowering to harvesting. **Vertical line indicates threshold level**.

Effect of RH after Flowering



* Microbial load (● Panhandle, ▪ South Central, ▲ Southeast) in response to the average relative humidity levels prevailing from flowering to harvesting. **Vertical line indicates threshold level**.

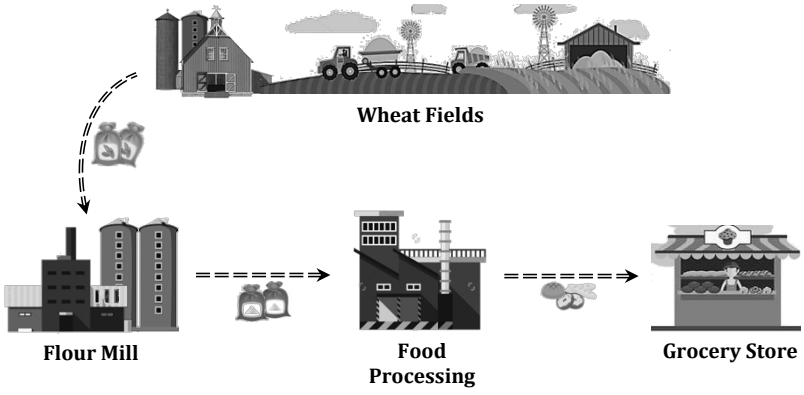
Indicators and Pathogens in Wheat Grain

Prevalence of indicators and pathogenic microorganisms in wheat grains in different geographic regions

Microorganisms	Geographic Origin [1]						
	Australia	Australia	Australia	Great Britain	United States	Hungary	Algeria
Escherichia coli	NR	NR	2 (50)	NR	NR	NR	NR
Coliforms	ND	93 (58)	NR	NR	NR	NR	NR
Salmonella spp.	NR	0.5 (412)	2 (50)	NR	NR	NR	NR
Bacillus cereus	NR	81.0 (58)	4 (50)	NR	NR	NR	NR
Reference	Eyles et al (1989)	Berghofer et al (2003)	Eglezos (2010)	Seiler (1986)	Manthey et al (2004)	Peles et al (2012)	Riba et al (2008)

[1] Values are percentages of positive samples. Sample sizes are provided in parentheses.
NR = not reported; ND = not detected.

Field-to-Table Continuum



Milling Process

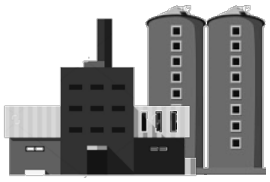
Wheat flour milling:

- ✓ No inherent **step to ensure safety**
- ✓ Cause a **redistribution of microorganisms** into milled fractions

Consequences:

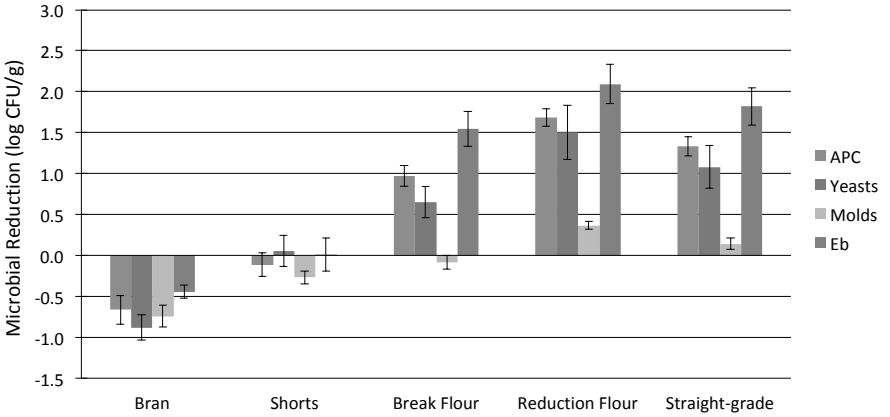
- ✓ The **initial microbiological quality** of the grain
- ✓ Cleanliness of **equipment and processing environment**

have a **strong influence** on the final **safety and quality** of the milling end products.



Flour Mill

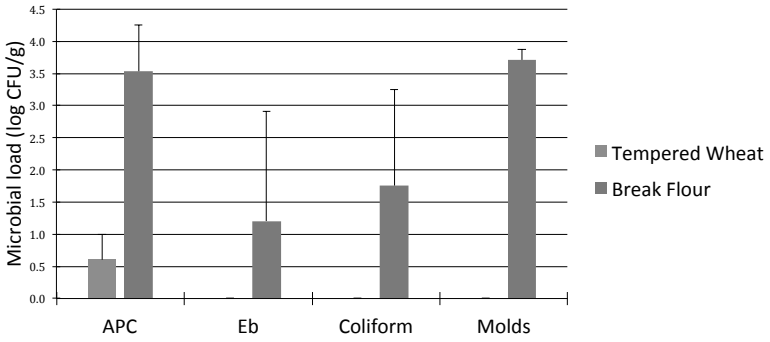
Microbial Distribution - Lab Milling



Initial Microbial Load	APC	Yeasts	Molds	Eb
Log CFU/g	5.9 ± 0.1	4.1 ± 0.2	2.9 ± 0.1	5.1 ± 0.2

Distribution of Aerobic Plate Count (APC), yeasts, molds and *Enterobacteriaceae* (Eb) in milling process and end products. Wheat samples were milled using a **Buhler MLU-202 Laboratory Mill**. Error bars denote ± standard deviation.

Influence of Equipment on End Product



Microbial profile of wheat tempered with lactic acid (5%) and NaCl (~26%) and the break flour produced from it by using a **Buhler MLU-202 Laboratory Mill**. Error bars denote ± standard deviation.

Influence of Equipment on End Product

Microbial load of wheat milled products:

Wheat milled products	Average Microbial Counts (log CFU/g) [x]					
	APC [y]	Coliform	Generic *E. coli*	Eb [y]	Yeasts	Molds
Incoming wheat	5.5 ± 0.2 a	1.0 ± 0.9 b	< 1.0 ± 0.0 [z]	3.2 ± 1.2 a	2.7 ± 0.9 a	2.9 ± 0.6 a
Dry clean wheat	5.3 ± 0.3 a	1.8 ± 1.7 ab	< 1.0 ± 0.0 [z]	3.9 ± 1.1 a	2.5 ± 1.1 a	2.8 ± 0.6 a
Tempered wheat	5.4 ± 0.4 a	1.3 ± 1.2 b	< 1.0 ± 0.0 [z]	3.7 ± 0.8 a	3.3 ± 1.2 a	2.6 ± 0.4 a
1st Break	4.9 ± 0.7 ab	1.9 ± 1.7 ab	< 1.0 ± 0.0 [z]	3.4 ± 0.7 a	1.8 ± 1.5 a	3.1 ± 0.5 a
3rd Break	4.5 ± 0.7 ab	2.3 ± 0.4 ab	< 1.0 ± 0.0 [z]	3.4 ± 1.1 a	2.1 ± 0.6 a	2.5 ± 0.3 a
5th Break	4.8 ± 0.8 ab	3.0 ± 0.1 ab	< 1.0 ± 0.0 [z]	3.6 ± 0.4 a	2.9 ± 1.4 a	2.9 ± 0.4 a
1st Middlings	3.5 ± 0.4 b	2.4 ± 0.3 ab	< 1.0 ± 0.0 [z]	2.7 ± 0.5 a	1.8 ± 0.6 a	2.5 ± 0.1 a
3rd Middlings	3.9 ± 0.3 ab	2.3 ± 0.2 ab	< 1.0 ± 0.0 [z]	2.3 ± 0.5 a	1.6 ± 1.4 a	2.6 ± 0.1 a
5th Middlings	4.9 ± 1.3 ab	2.8 ± 0.5 ab	< 1.0 ± 0.0 [z]	3.2 ± 0.2 a	2.2 ± 0.9 a	2.9 ± 0.9 a
Straight-grade flour	3.9 ± 0.5 ab	2.1 ± 0.5 ab	< 1.0 ± 0.0 [z]	2.2 ± 0.7 a	1.6 ± 0.5 a	3.0 ± 0.6 a
Bran	5.3 ± 0.2 a	3.2 ± 0.5 ab	< 1.0 ± 0.0 [z]	3.4 ± 1.0 a	2.9 ± 1.1 a	2.6 ± 0.6 a
Shorts	5.1 ± 0.4 ab	3.0 ± 0.5 ab	< 1.0 ± 0.0 [z]	3.6 ± 0.8 a	2.7 ± 0.6 a	2.8 ± 0.4 a
Germ	5.1 ± 0.5 ab	3.7 ± 1.0 a	< 1.0 ± 0.0 [z]	4.0 ± 1.1 a	2.6 ± 1.0 a	3.0 ± 1.1 a

Indicators and Pathogens in Wheat Flour

Prevalence of indicators and pathogenic microorganisms in wheat flour in different geographic regions

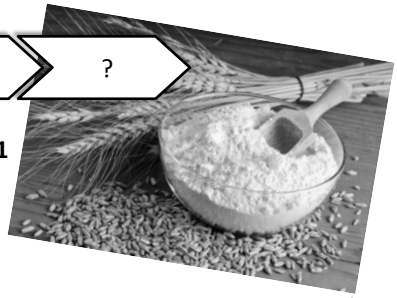
Microorganisms	**Geographic Origin [1]**					
	Turkey	Australia	Australia	United States	United States	Pakistan
Escherichia coli	50.7 (142)	1.4 (71)	0.7 (300)	12.8 (3350)	0.7 (2921)	NR
Coliforms [2]	NR	1.0 – 1000 (71)	NR	1.2 (1477)	1.6 (3,688)	3.0 - 4.0 (150)
Salmonella spp.	NR	NR	ND (150)	1.3 (3040)	0.14 (4358)	NR
Bacillus cereus	4.2 (142)	93 (71)	ND (350)	NR	NR	NR
C. perfringens	9.9 (142)	NR	NR	NR	NR	NR
Reference	Aydin et al (2009)	Berghofer et al (2003)	Eglezos (2010)	Richter et al (1993)	Sperber (2007)	Batool et al (2012)

[1] Values are percentages of positive samples. Sample sizes are provided in parentheses.
[2] Expressed as most probable number per gram (MPN/g).
NR = not reported

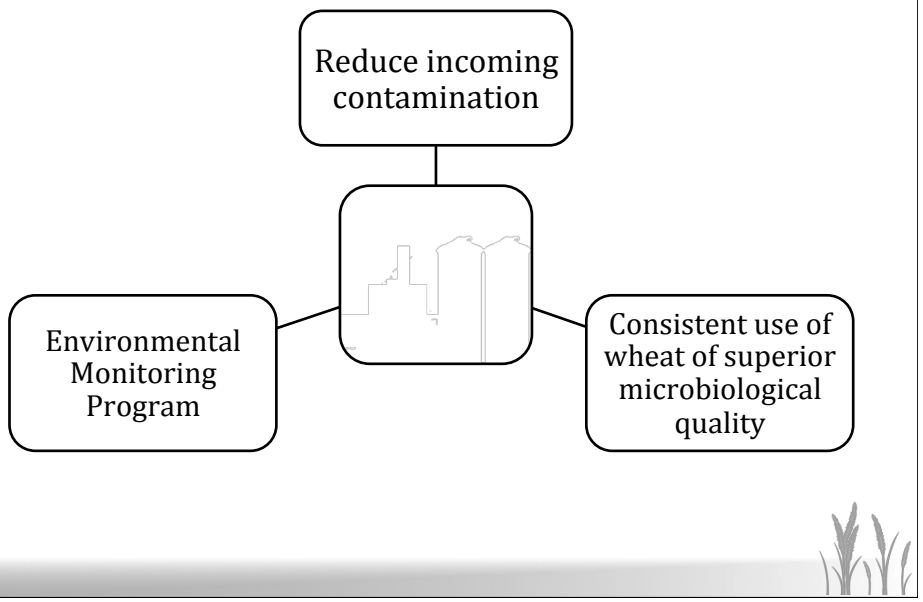
Outbreaks Involving the Grain Industry

1952	2005	2008	2009
Australia ***Salmonella***	USA ***Salmonella***	New Zealand ***Salmonella***	USA ***E. coli* O157**

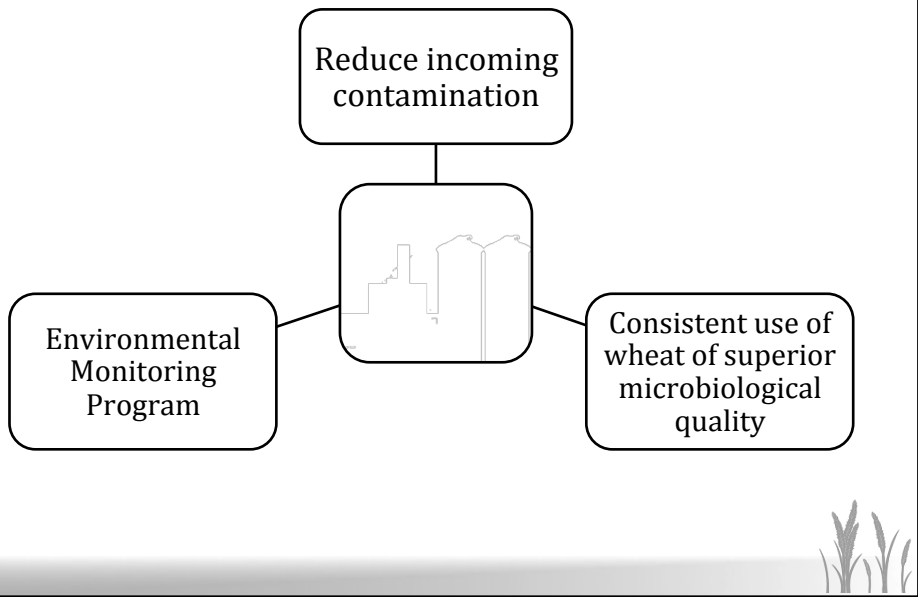
2015	2016	2017	?
USA ***Salmonella***	USA ***E. coli* O121** ***E. coli* O26**	Canada ***E. coli* O121**	



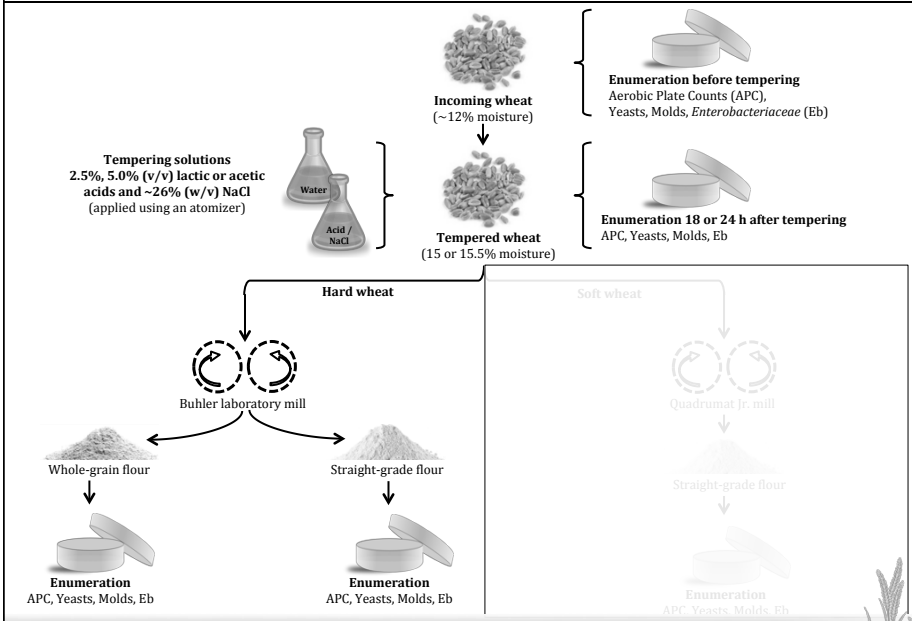
Interventions?



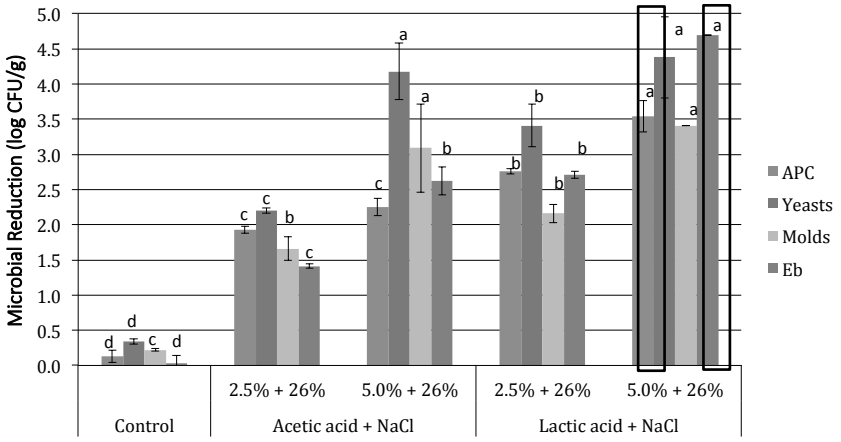
Interventions?



Microbial Reduction – Novel Tempering

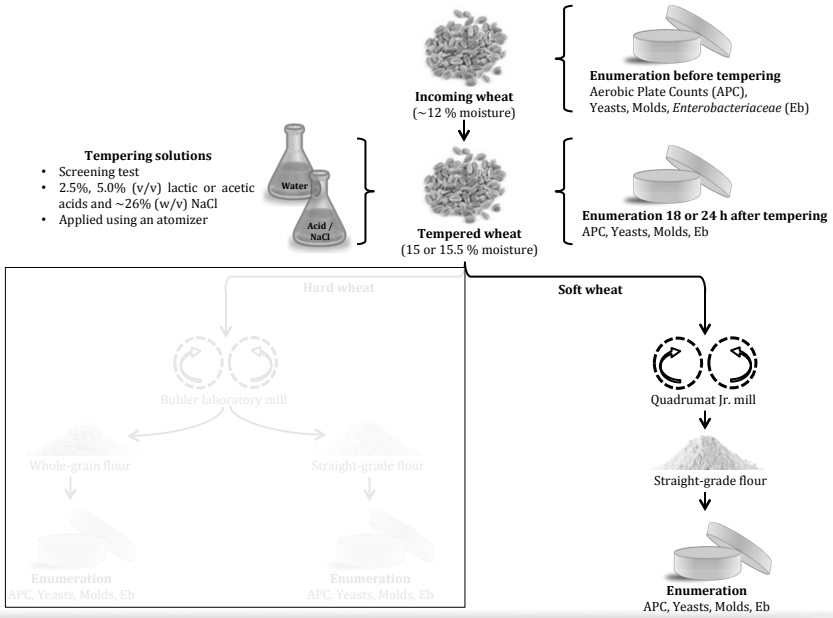


Microbial Reduction – HRW Wheat

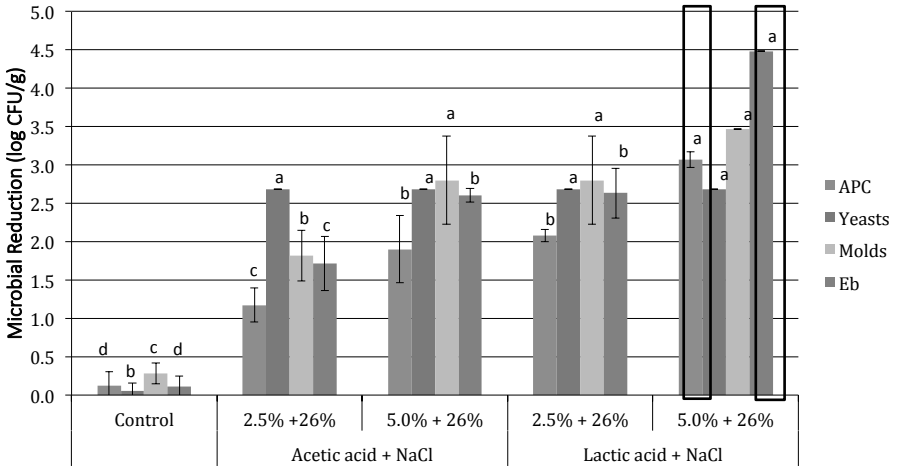


Effect of the combined addition of organic acid and NaCl in tempering water on reducing Aerobic Plate Counts (APC), yeasts, molds and *Enterobacteriaceae* (Eb) in hard wheat grain. Error bars denote ± standard deviation. Log reduction values with the same letter, within the same microorganism, are not significantly different ($p>0.05$).

Microbial Reduction – Novel Tempering

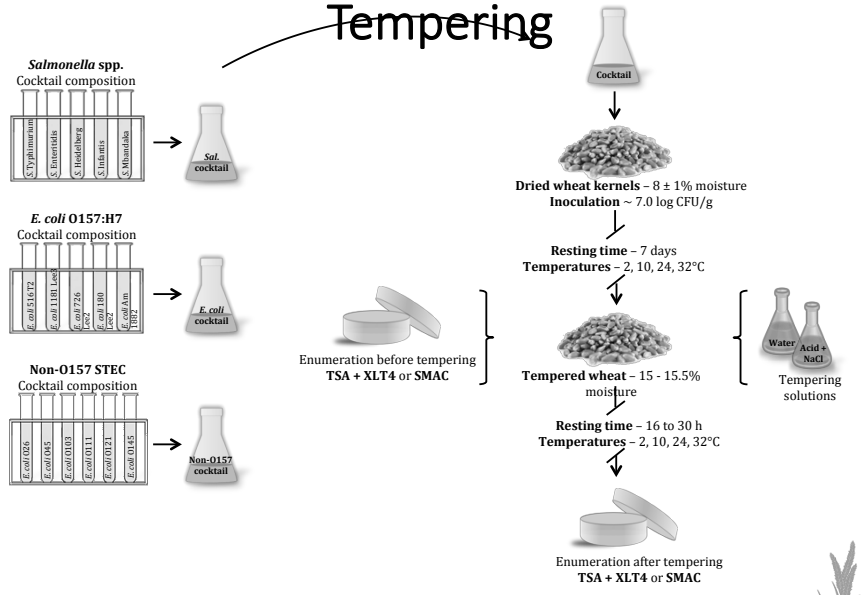


Microbial Reduction – SRW Wheat

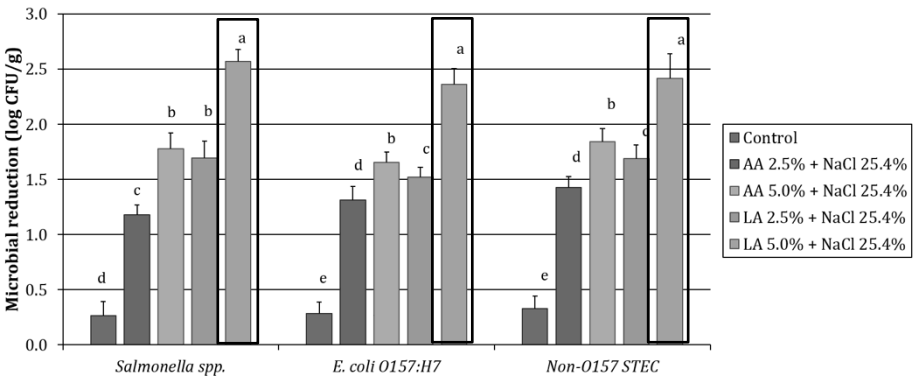


Effect of the combined addition of organic acid and NaCl in tempering water on reducing Aerobic Plate Counts (APC), yeasts, molds and *Enterobacteriaceae* (Eb) in soft wheat grain. Error bars denote ± standard deviation. Log reduction values with the same letter, within the same microorganism, are not significantly different ($p>0.05$).

Pathogenic Reduction – Novel Tempering

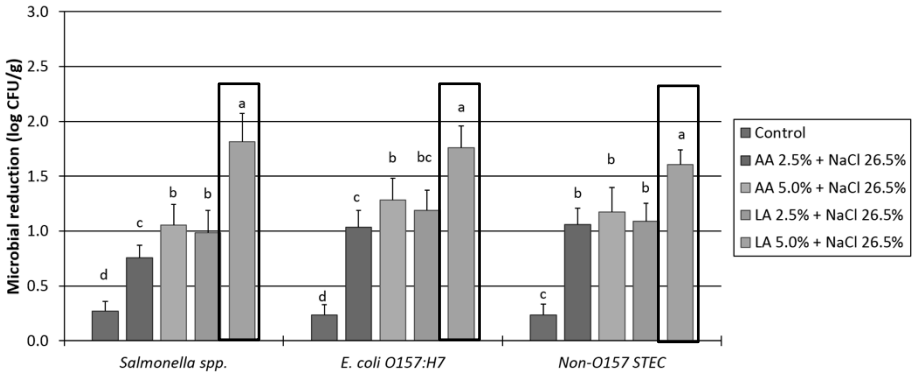


Pathogenic Reduction – HRW Wheat



Effect of organic acid saline solutions on *Salmonella* spp. (A), *E. coli* O157:H7 (B), and non-O157 STEC (C) during hard wheat tempering. Error bars denote ± standard deviation. Acetic acid (AA); Lactic acid (LA); Sodium chloride (NaCl). Percentage denotes concentration.

Pathogenic Reduction – SRW Wheat



Effect of organic acid saline solutions on *Salmonella* spp. (A), *E. coli* O157:H7 (B), and non-O157 STEC (C) during soft wheat tempering. Error bars denote ± standard deviation. Acetic acid (AA); Lactic acid (LA); Sodium chloride (NaCl). Percentage denotes concentration.

Effect of Tempering Methods on Flour Functionality

Cereal Chemistry Journal, In Press
doi:10.1094/CCHEM-07-16-0197-R

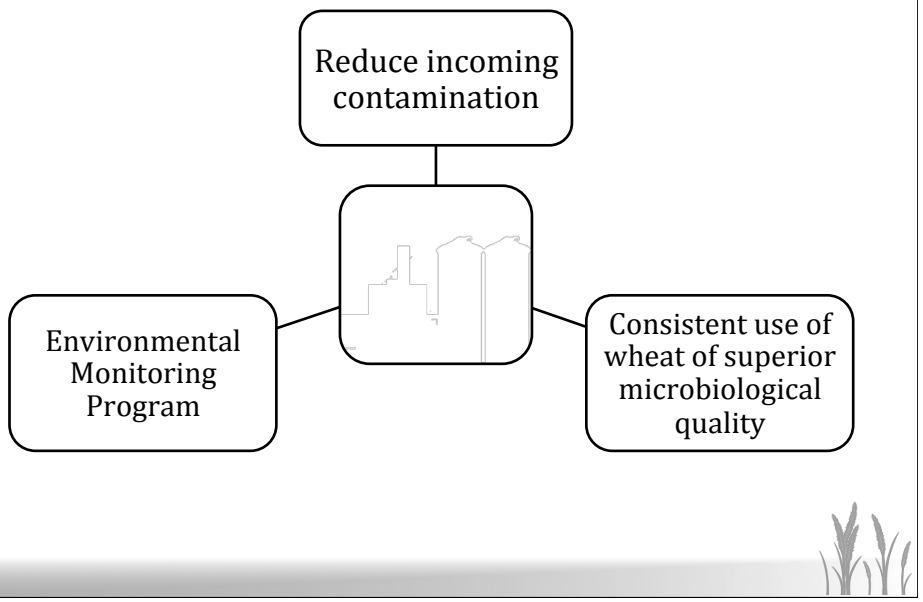
Effect of Saline Organic Acid Solutions Applied during Wheat Tempering on Flour Functionality

LUIS SABILLÓN [1,2], ANDRÉIA BIANCHINI [1,2], JAYNE STRATTON [1,2], AND DEVIN J. ROSE [1,3]*

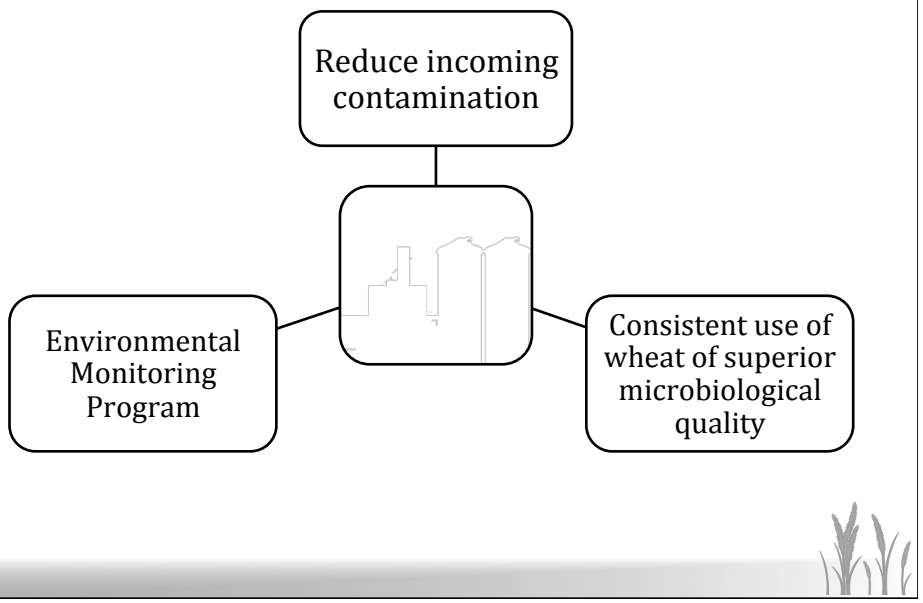
[1]Department of Food Science and Technology and [2]The Food Processing Center, University of Nebraska–Lincoln, Lincoln, Nebraska 68588;
and [3]Department of Agronomy and Horticulture, University of Nebraska–Lincoln, Lincoln, Nebraska 68583, USA

66

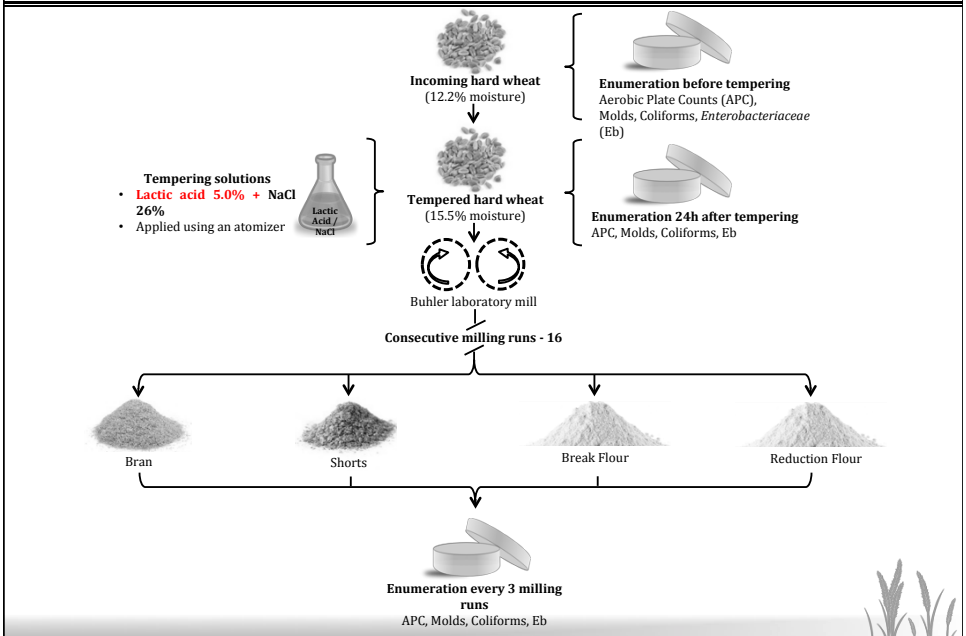
Interventions?



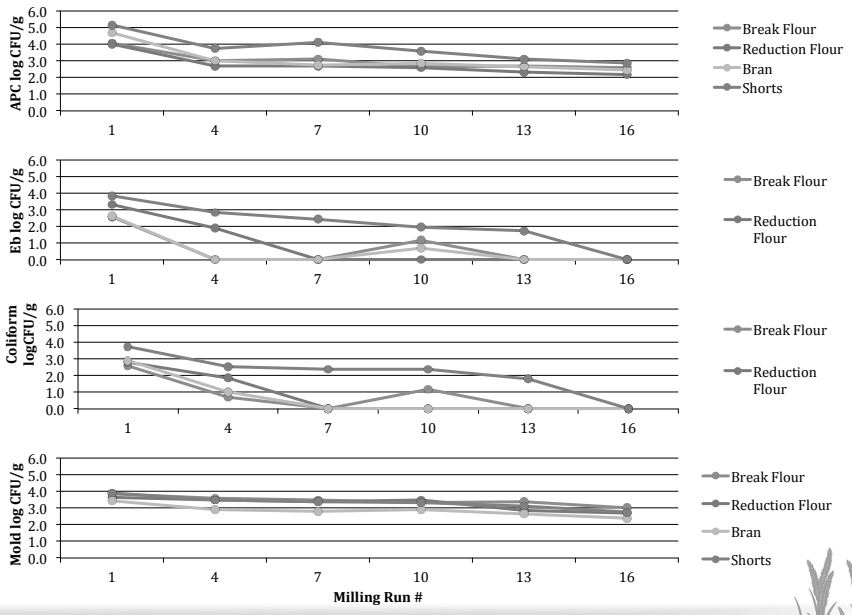
Interventions?



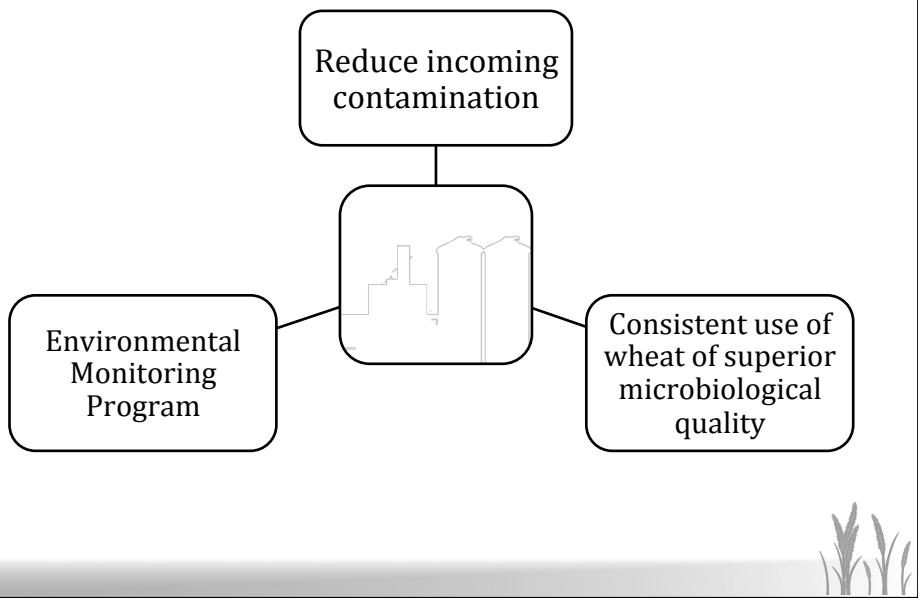
Reduction of Microbial Load within the Mill



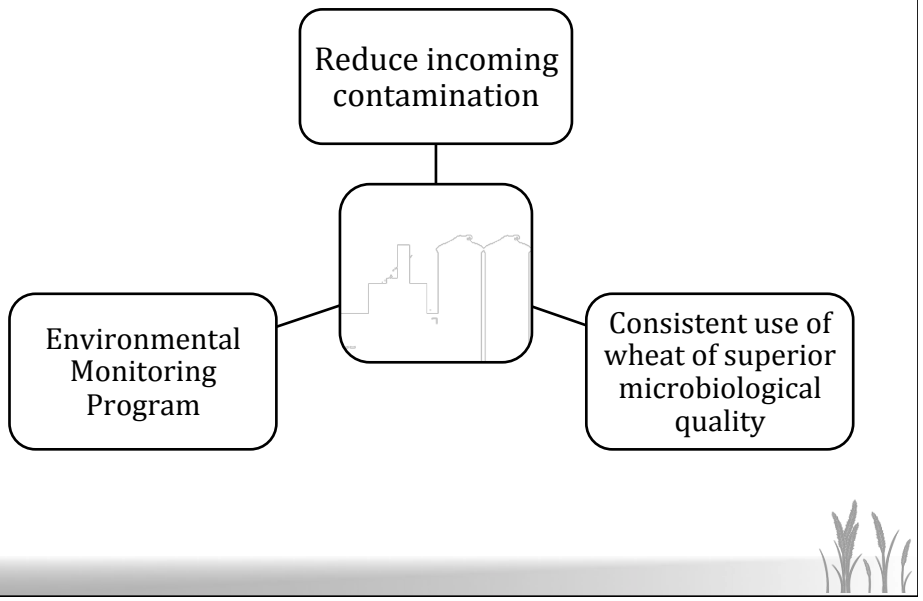
Reduction of Microbial Load within the Mill



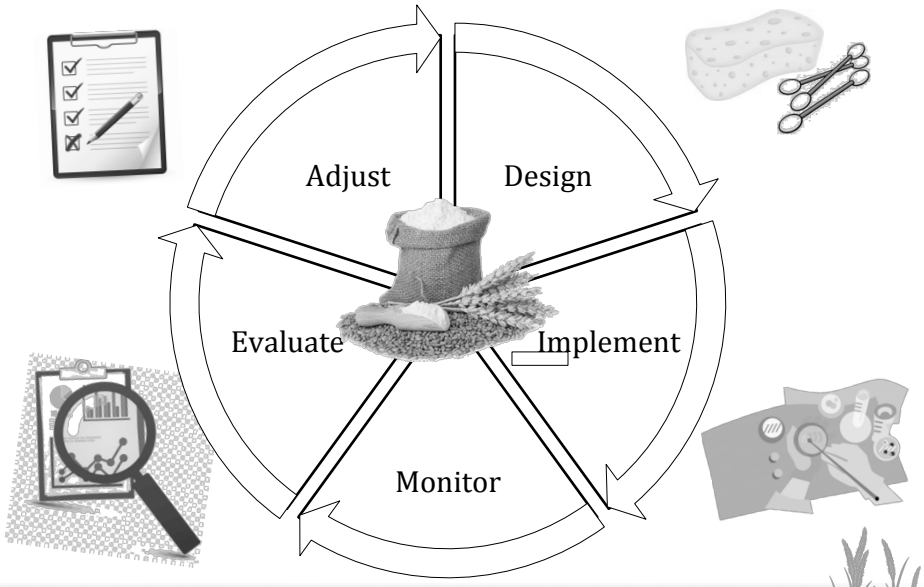
Interventions?



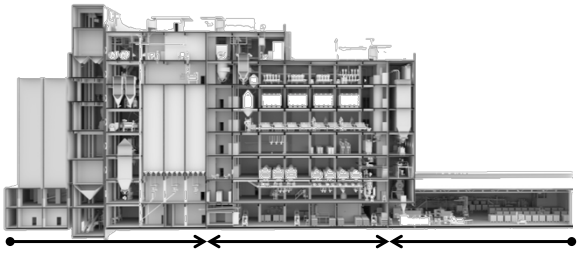
Interventions?



Environmental Monitoring Program



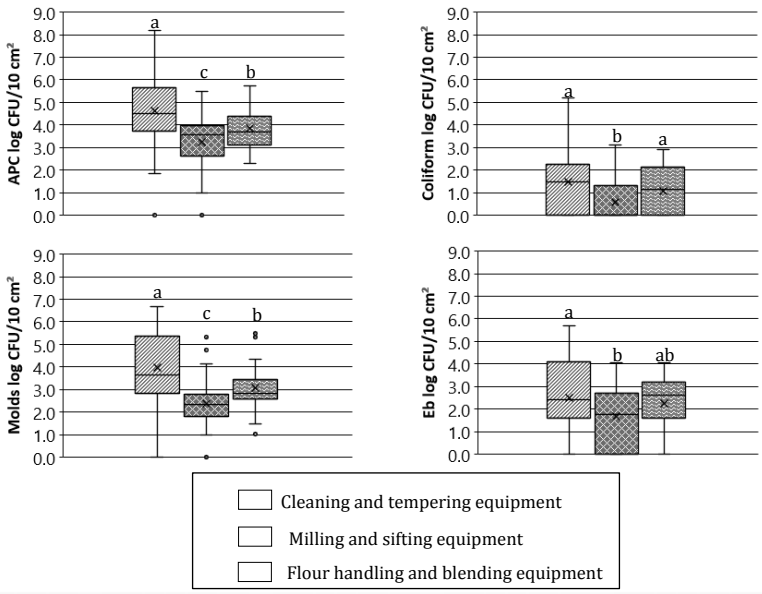
Environmental Survey



Number of samples collected in each microbial survey:

Sampling Site	Number of Samples Collected			
	First Survey	Second Survey	Third Survey	Fourth Survey
Cleaning & Tempering	24	24	19	6
Milling	43	43	42	36
Packing & Storage	13	13	12	13
Milled Fractions	14 (soft wheat) 13 (hard wheat)	14 (soft wheat) 0 (hard wheat)	16 (hard wheat)	16 (hard wheat)

Microbial Load on Equipment Surface



Microbial Load on Equipment Surface

Microbial load associated with selected equipment used to process the wheat and handle the resulting flour.

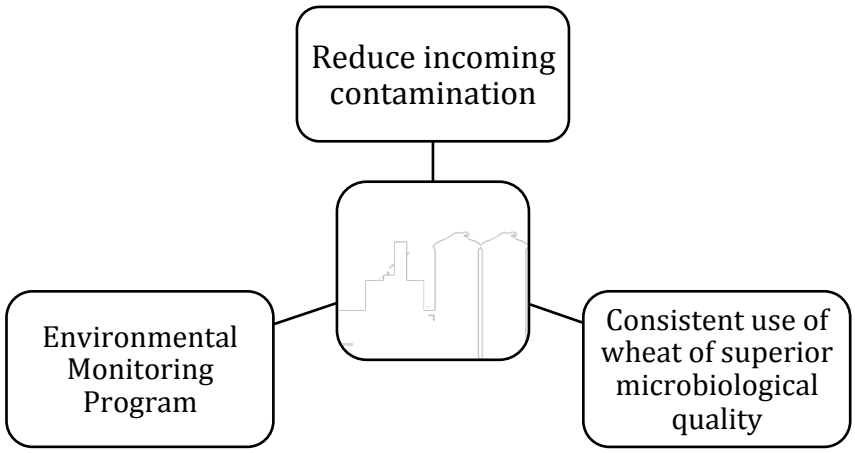
Sample Location	Average Microbial Counts (log CFU/10 cm²) [x]					
	APC [y]	Coliform	Generic *E. coli*	Eb [y]	Yeasts	Molds
Cleaning and tempering equipment						
Water addition system (Turbolizer)	7.0 ± 1.6	4.3 ± 1.2	< 1.0 ± 0.0 [z]	4.8 ± 0.7	3.9 ± 1.8	3.3 ± 0.5
Milling and sifting equipment						
Inside walls of grinding machines	4.3 ± 0.7	1.7 ± 0.5	< 1.0 ± 0.0 [z]	2.1 ± 0.4	1.4 ± 1.1	3.3 ± 0.7
Walls of sifter boxes	3.3 ± 1.0	0.7 ± 0.9	< 1.0 ± 0.0 [z]	1.5 ± 1.4	0.8 ± 1.0	2.2 ± 0.8
Flour handling and storage equipment						
Twin screw conveyors	3.7 ± 0.1	1.5 ± 0.5	< 1.0 ± 0.0 [z]	2.1 ± 0.3	2.1 ± 0.2	2.9 ± 0.1
Product scales	5.3 ± 1.0	1.6 ± 0.6	< 1.0 ± 0.0 [z]	1.4 ± 1.2	1.4 ± 1.2	4.7 ± 1.1

[x] Values represents average ± standard deviation.

[y] APC, aerobic plate count; Eb, *Enterobacteriaceae*.

[z] Values are below the limit of detection of 1.0 log CFU/10 cm².

Increased Safety!



The Take-Home Message…

- ✓ **Organic acids and salt** in tempering water may **reduce the risk of microbial contamination** in milled products
- ✓ Consistent use of this process would ensure **more sanitary milling operations**
  - ❖ Help preventing microbial establishment and growth within the mill
  - ❖ **Reduced risk of post-processing contamination** during milling
- ✓ **Environmental Monitoring Program** assists in identifying critical control points in the process

Acknowledgments

- ✓Graduate and Undergraduate Students
- ✓Collaborators
  - ❖UNL: Jayne Stratton and Devin Rose
- ✓Funding Sources:
  - ❖UNL Hatch Funds
  - ❖Industry

AGRICULTURAL RESEARCH DIVISION