



Intervenciones Químicas en el Procesamiento Avícola



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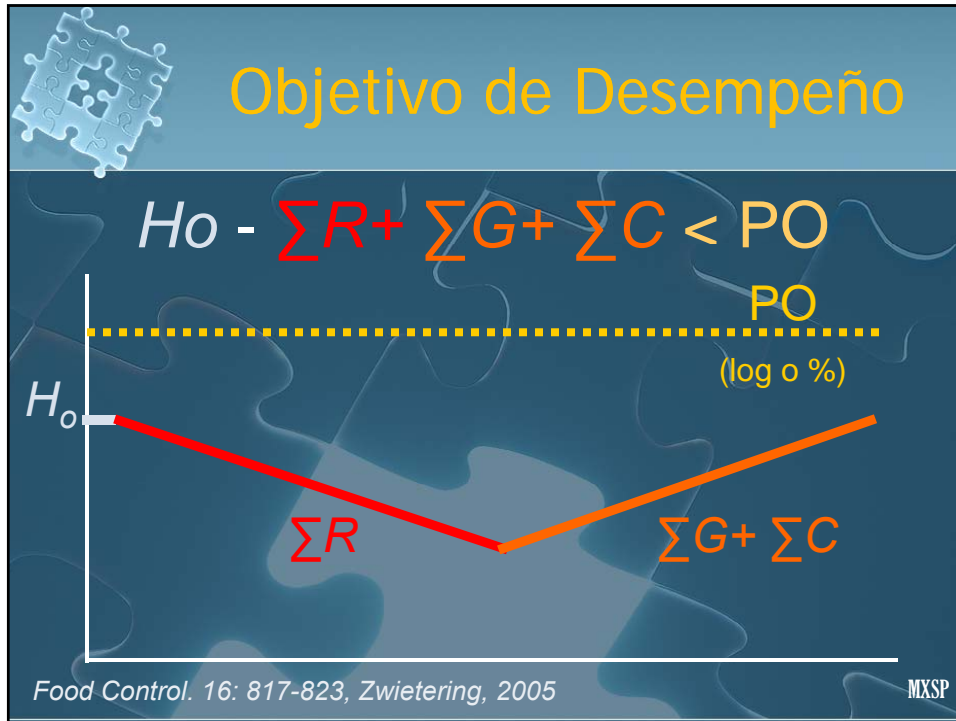
Objetivo de Desempeño

Prevalencia o concentración máxima de un peligro en el alimento en un paso específico **ANTES** de su consumo

Ejemplo:

Prevalencia de *Salmonella* luego del chiller NO debe ser mayor a 20% en pollos





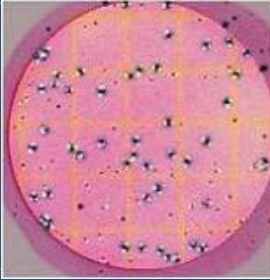

Objetivo de Desempeño Estándares de Pollo

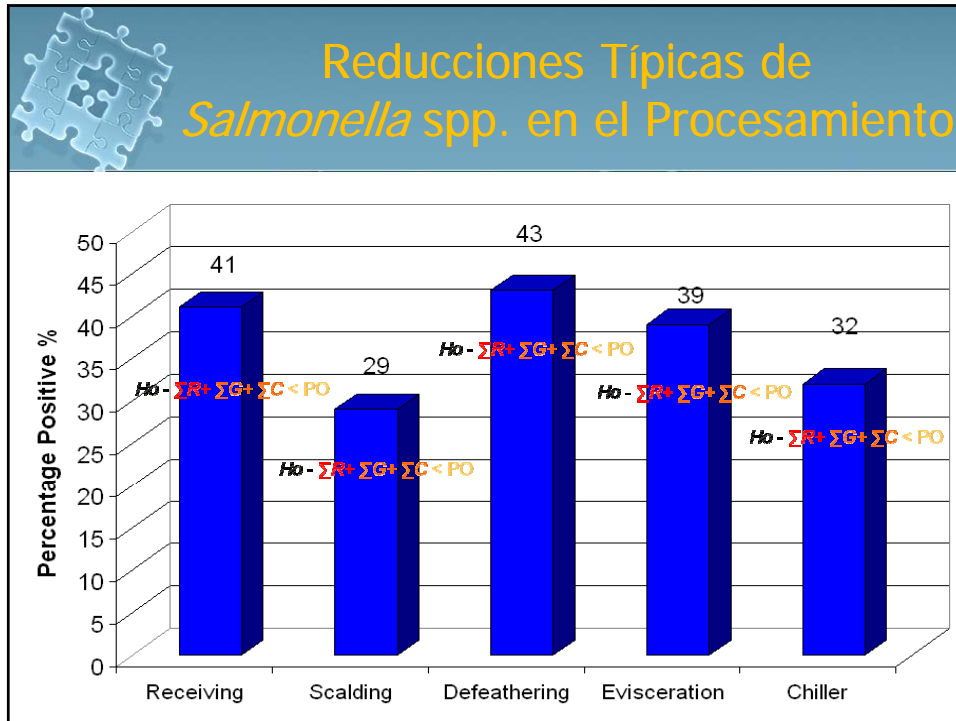
Concentración:

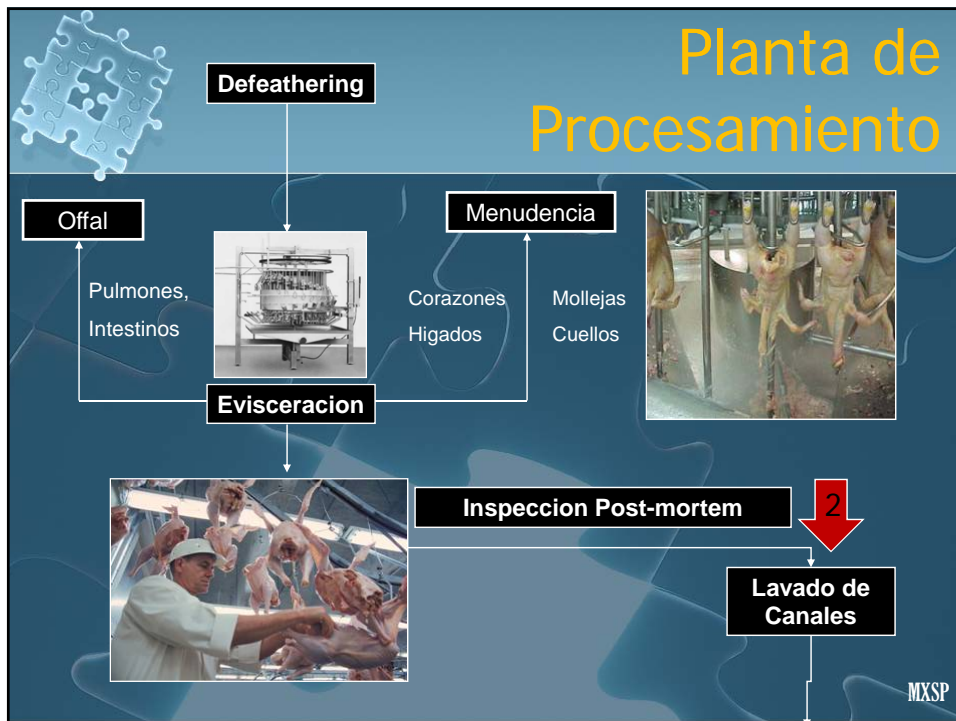
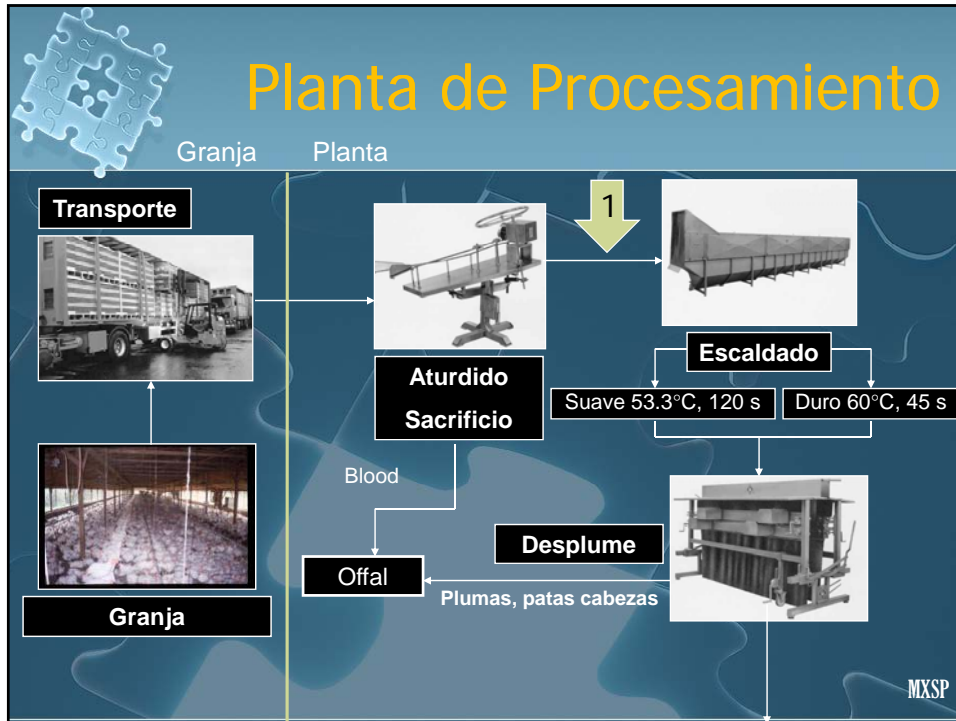
E. coli genérica en pollo crudo:
 1 muestra por 22,000 procesados
 m: <100 cfu (2 log)/ ml de enjuague
 M: < 1,000 cfu (3 log)/ ml de enjuague
 13 muestreos "ventana móvil"

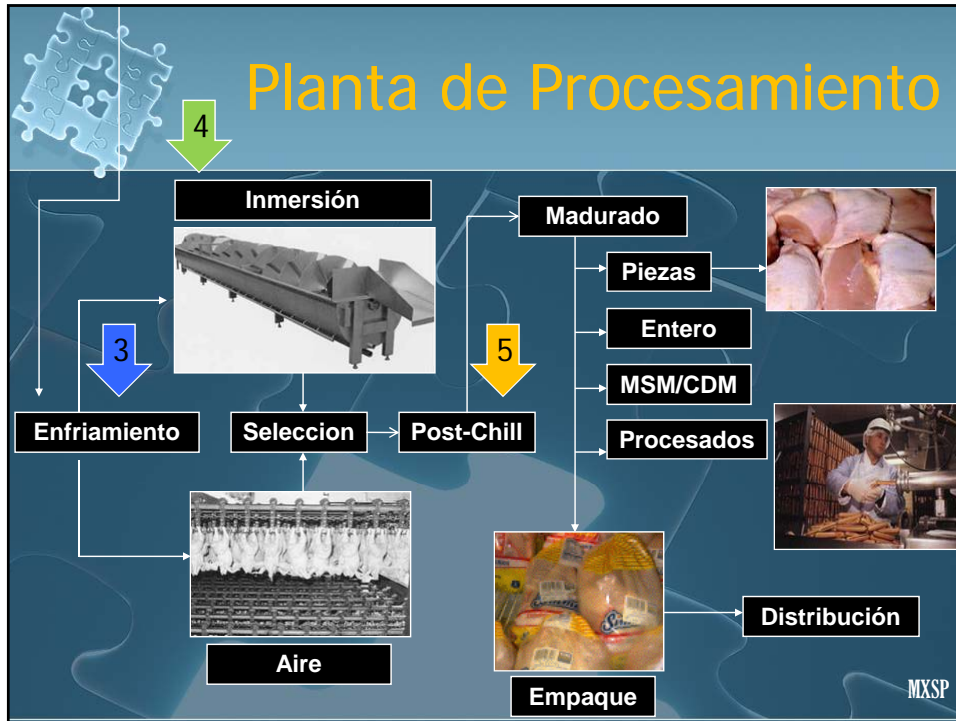
Prevalencia:

Salmonella spp. en pollo crudo:
 <20%
 <13 in 51 canales





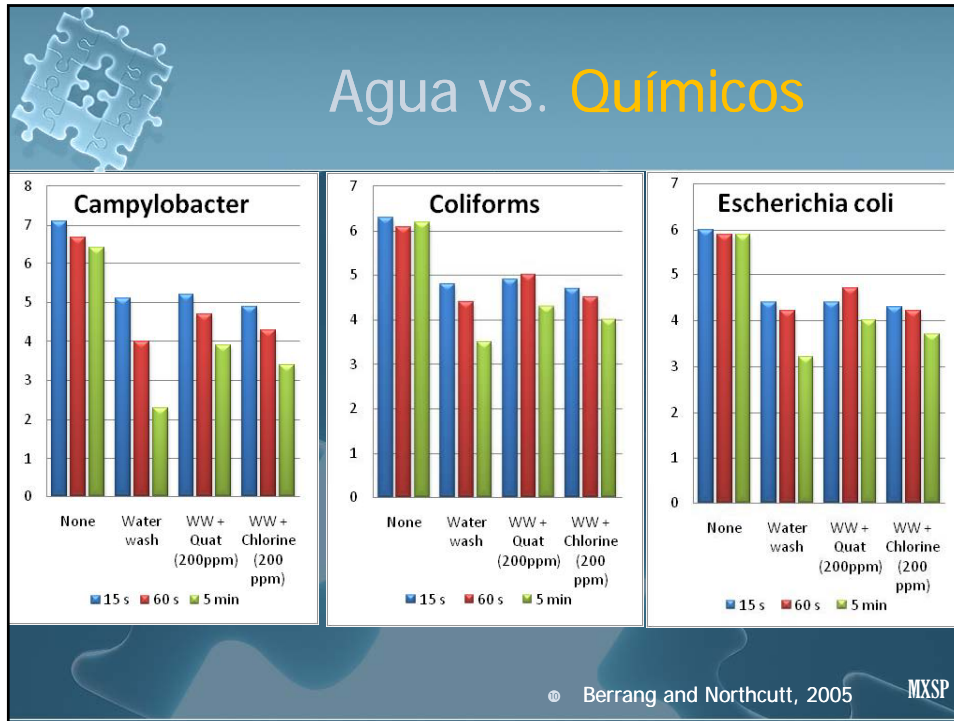


Intervenciones en Transporte

Lavado y Saneamiento

- Costoso
- Uso de Agua
- Aplicación Comercial?
- Químicos?
- Tiempo de acción
- Material orgánico
- Remoción física

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Intervenciones en el Escaldado

- Cepillos/ lavados pre-escaldado
- Flujo contracorriente
- Sistemas de filtrado (orgánicos)
- Sistemas multi-tanque: 3
- Control de: Temperatura
pH y ORP
- Reflujo agua fresca
- Antimicrobianos
 - Cloro (50% de plantas)
 - Hidróxido de Sodio 1% (50% de plantas)
 - Acido Sulfúrico + Sulfato de Cobre
 - Mezcla de ácidos orgánicos, fosfatos

shaken

Tank 1 Tank 2 Tank 3

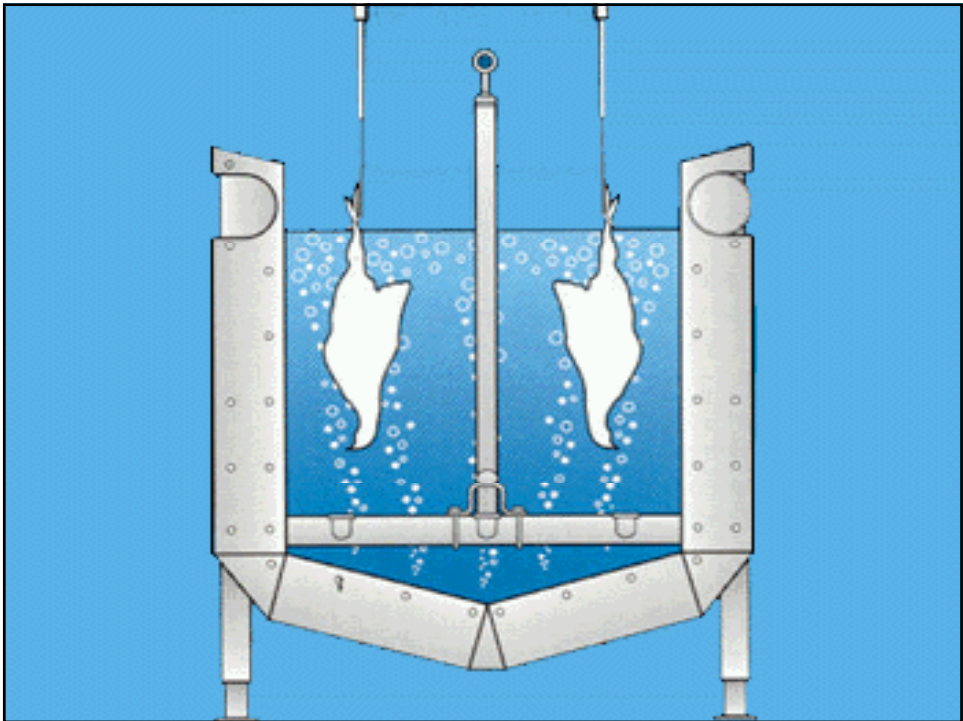


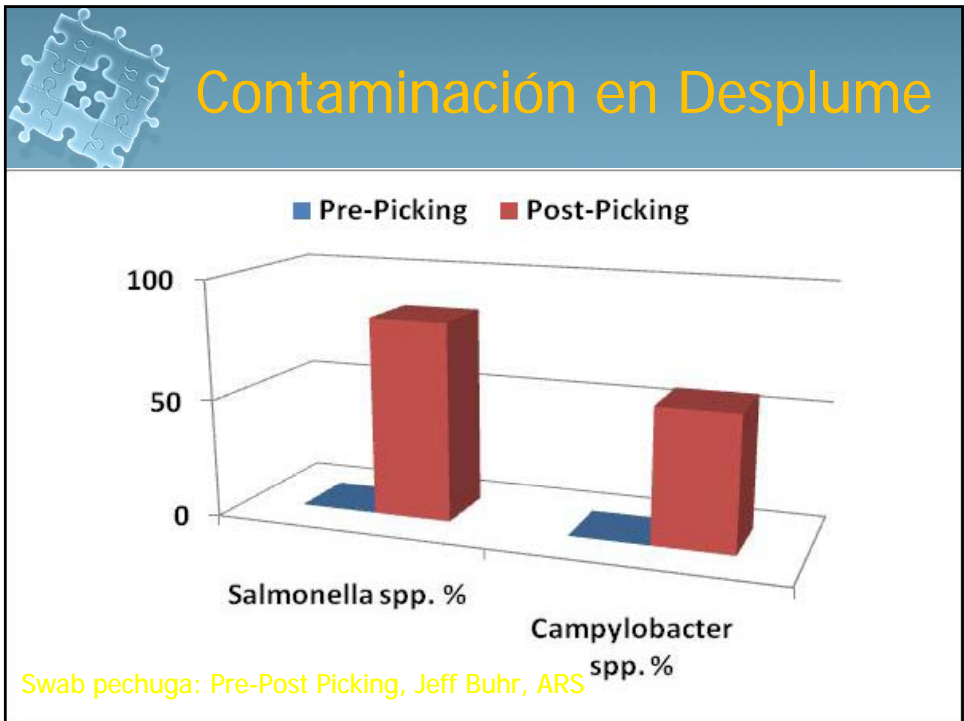
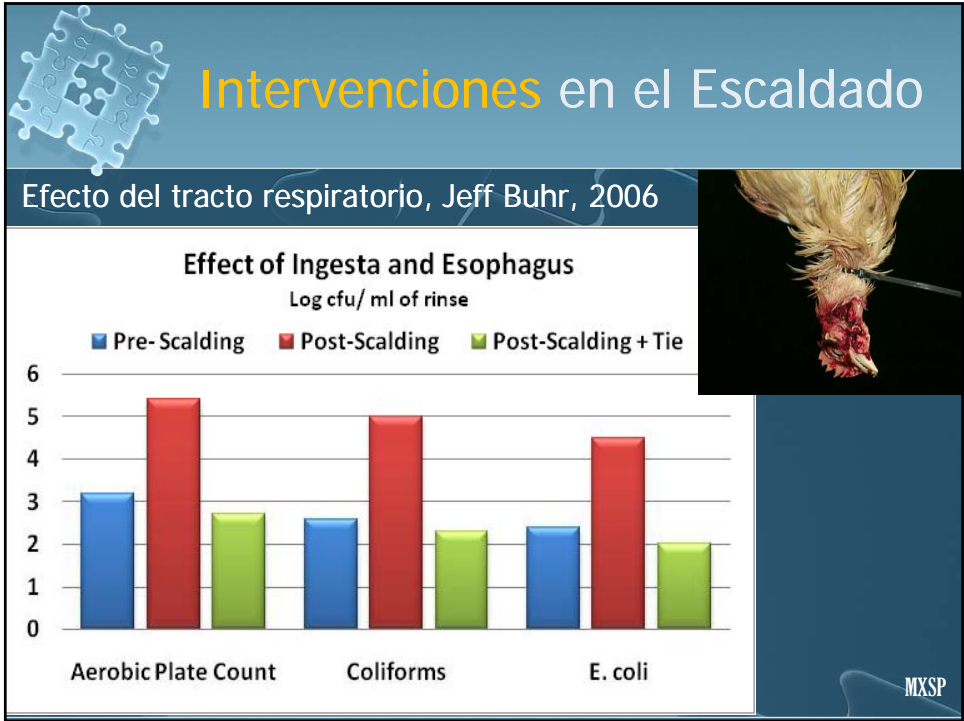
 **Lavadoras de Canales**



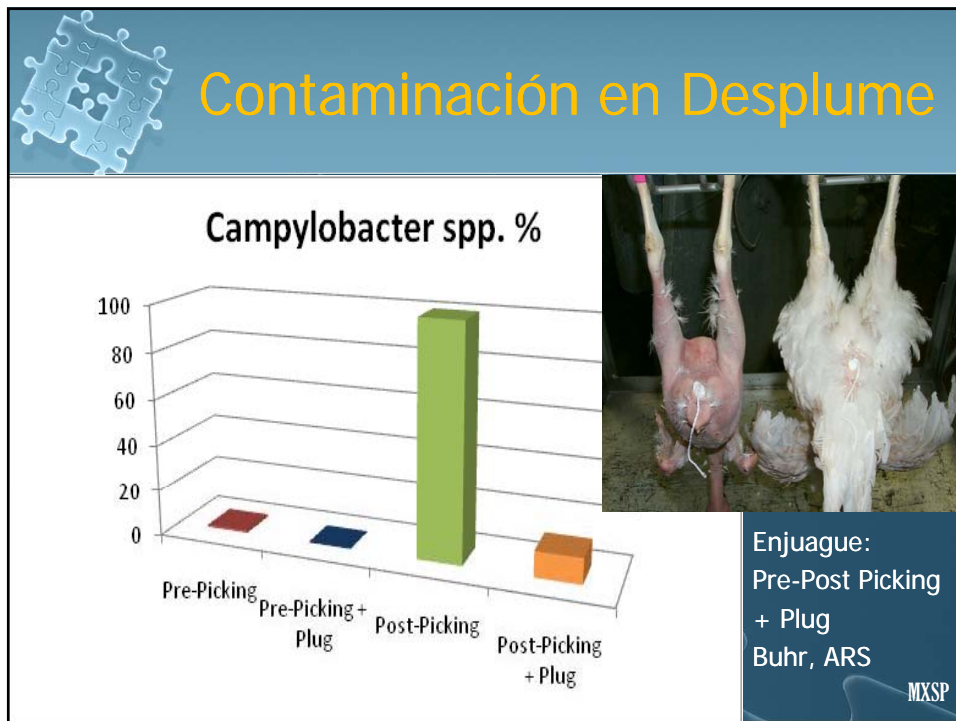
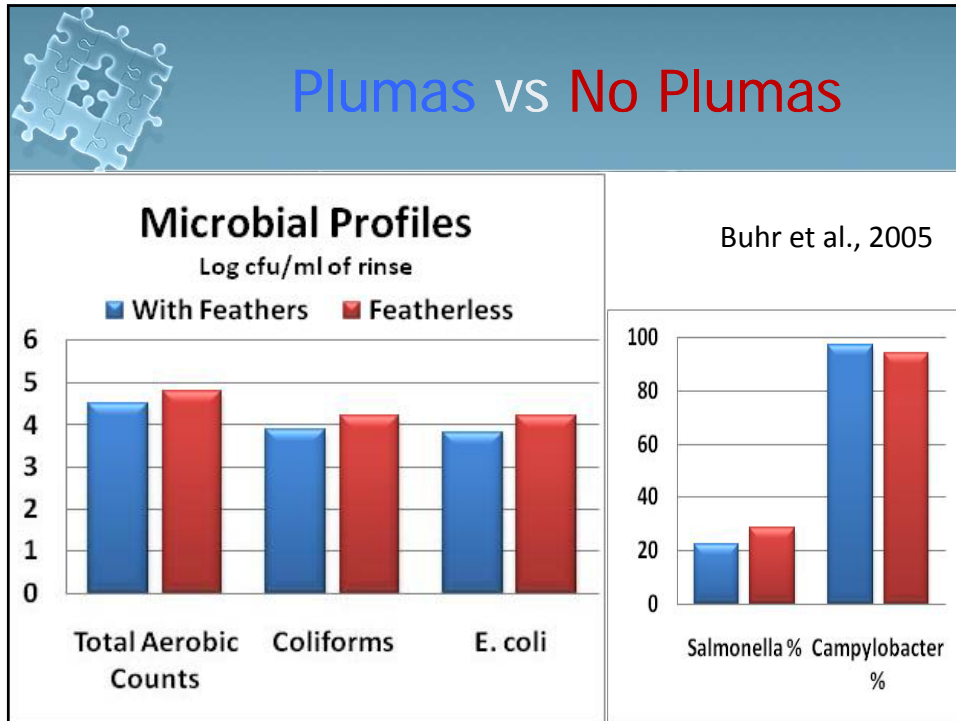
Hasta 280 bpm

Dr. Jeff Buhr, ARS MXSP












 **Intervenciones** Desplume

Reducir contaminación cruzada
Remoción de plumas
Enjuague continuo
Ajuste de dedos

Enjuagues a 72°C (160°F)
Enjuague de H₂O₂
Acido sulfúrico y Sulfato de cobre





Intervenciones en Evisceración

- BPM
- SSOP (POES)
- Enjuagues de canales
- Ajuste de equipos
- Nuevas tecnologías
- Ganchos
- Sistemas de alta velocidad
- Sistemas de Evisceración Total

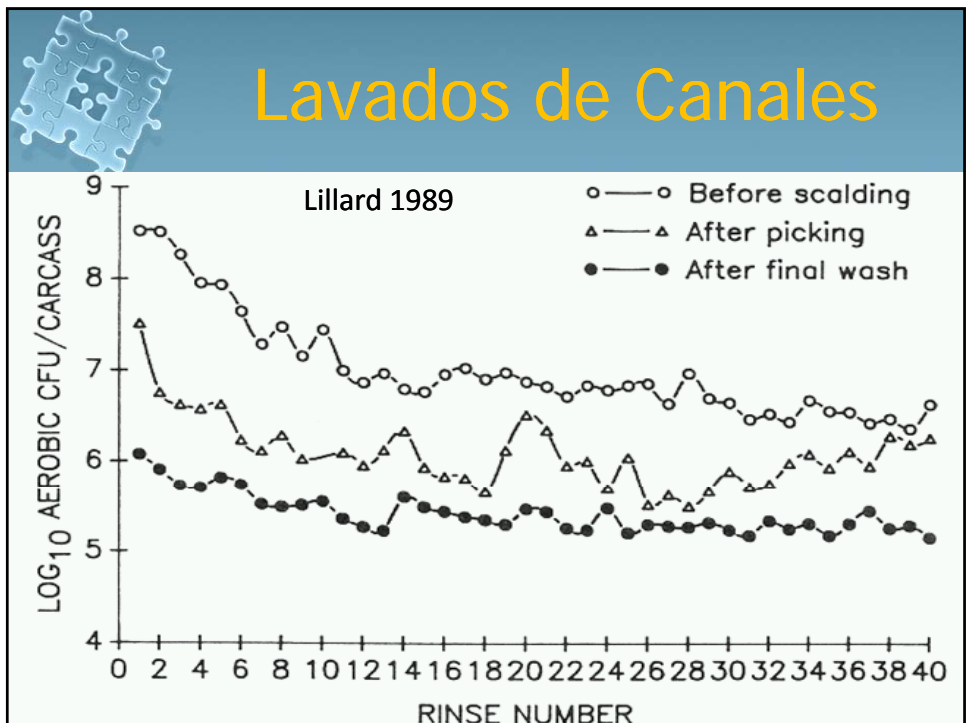




Lavadoras de Canales

Agua
Cloro (50ppm)
Antimicrobianos







Características de la Piel

Thomas and McMeekin, 1984



Piel de pollo antes de inmersión Piel de pollo, 30 min de inmersión

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Intervenciones Antimicrobianas Pre Chiller

23 -50 ppm **Cloro** Libre Disponible
Salmonella de 5 a 2%


Clorito Acidificado de Sodio: 500- 1,200ppm
pH 2.3-2.9 (Acido cítrico)

10% **TSP*** **Fosfato Trisódico** **Adherencia**
Reducciones de 1.36 log

Dióxido de Cloro 10ppm
Forma más estable (chiller o enjuagues)

Mezclas sinérgicas de **Ácidos Orgánicos**
Acido Cítrico, Acido Láctico, TSP

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Intervenciones Antimicrobianas Pre Chiller

- 85ppm **Acido Peracético**
Reducciones de 1.00 log
- 5% **Cloruro de Cetilpiridinio CPC**
Reducciones de 1.62 log (Enjuague bucal)
- Bromuro**
Reducciones de 1 a 3.00 logs
- Sistema **CO₂/ Cloro**
Reducciones de 1 a 3.00 logs
- Agua Electrolizada (NaCl)**
Anión (parte ácida) + Cation (parte básica)
 $NaCl + H_2O = HClO^- + NaOH$

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Intervenciones Antimicrobianas Pre Chiller

- 10% **TSP** + 25 ppm **Cloro** libre disponible
Reducciones de 1.44 log
- Sulfato Acidificado de Calcio**
Reducciones de 1 a 3.00 logs
- Ozone**
Chiller or equipment washdown
- 2% **Acido Láctico**
Reducciones de 1.21 log
- 5% **Bisulfato de Sodio**
Reducciones de 1.47 log
- Fotoionización**
LUZ UV (superficie de producto, empaque)

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Problemas con Antimicrobianos

Inocuidad

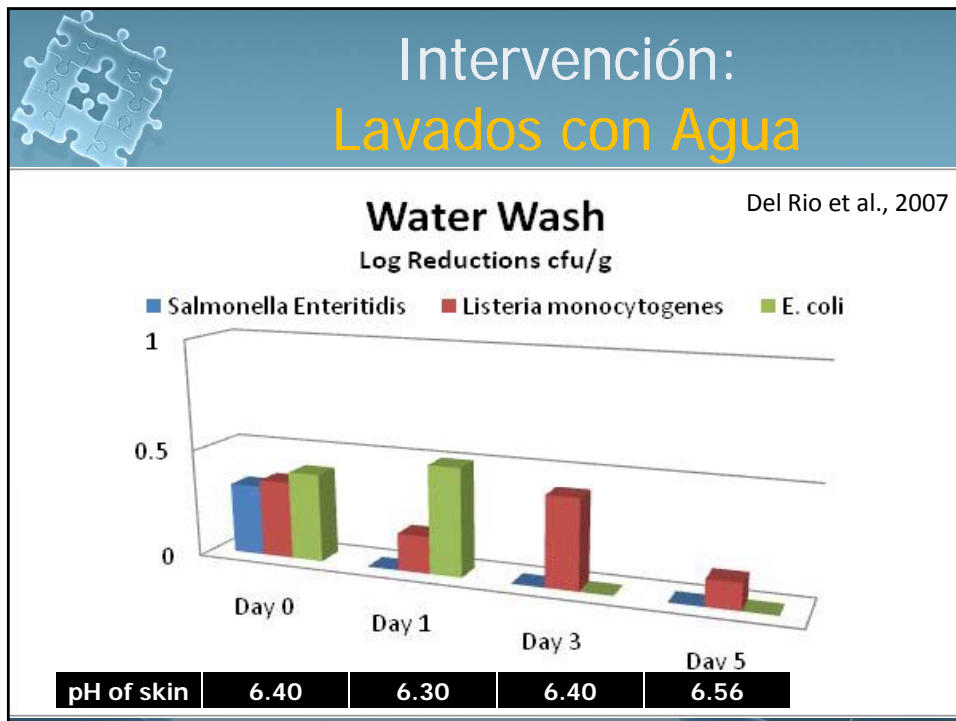


Mercados de exportación

Técnica de muestreo

Neutralización del químico en el enjuague

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Intervención: Cloro

GRAS "*Generally Recognized As Safe*"

Limites como aditivo

Se puede usar en agua de procesamiento:
10–30 ppm

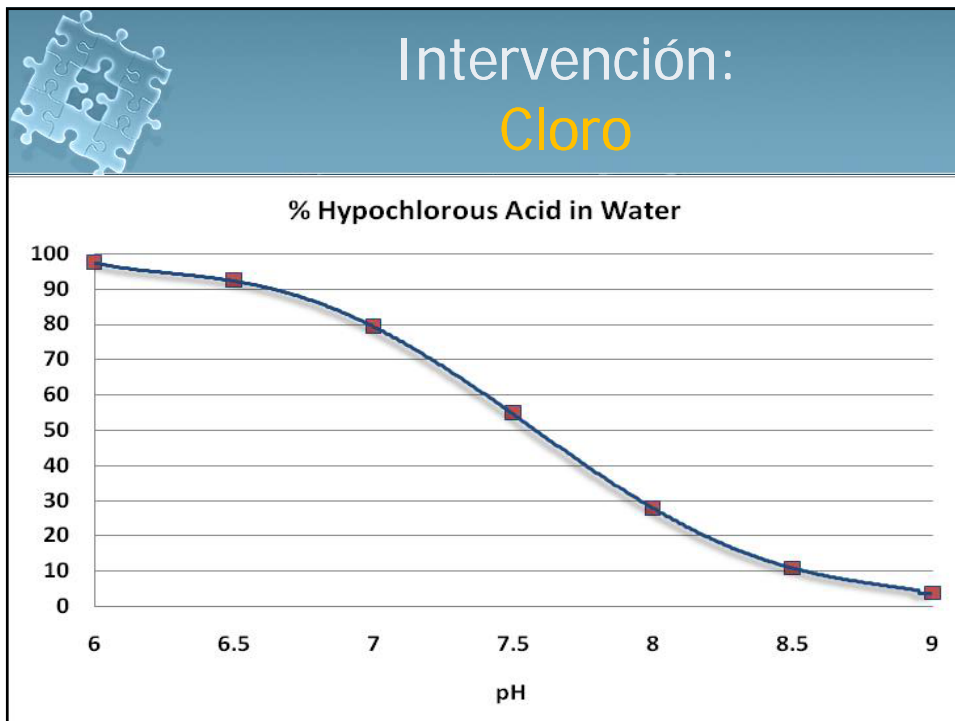
Espray, diluvio (deluge), inmersión
50ppm max.

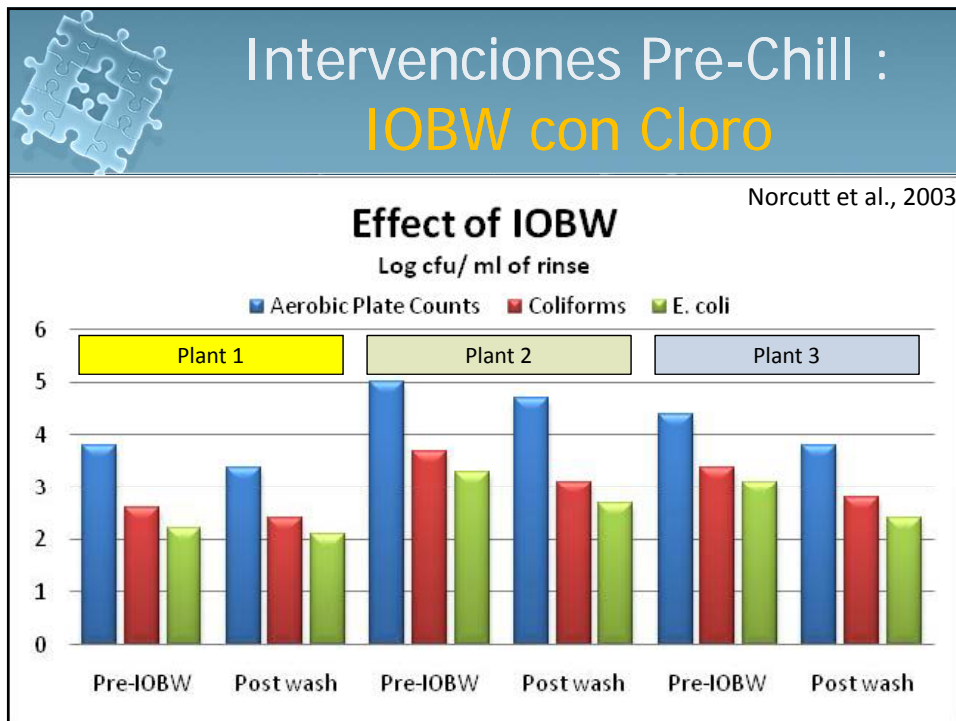
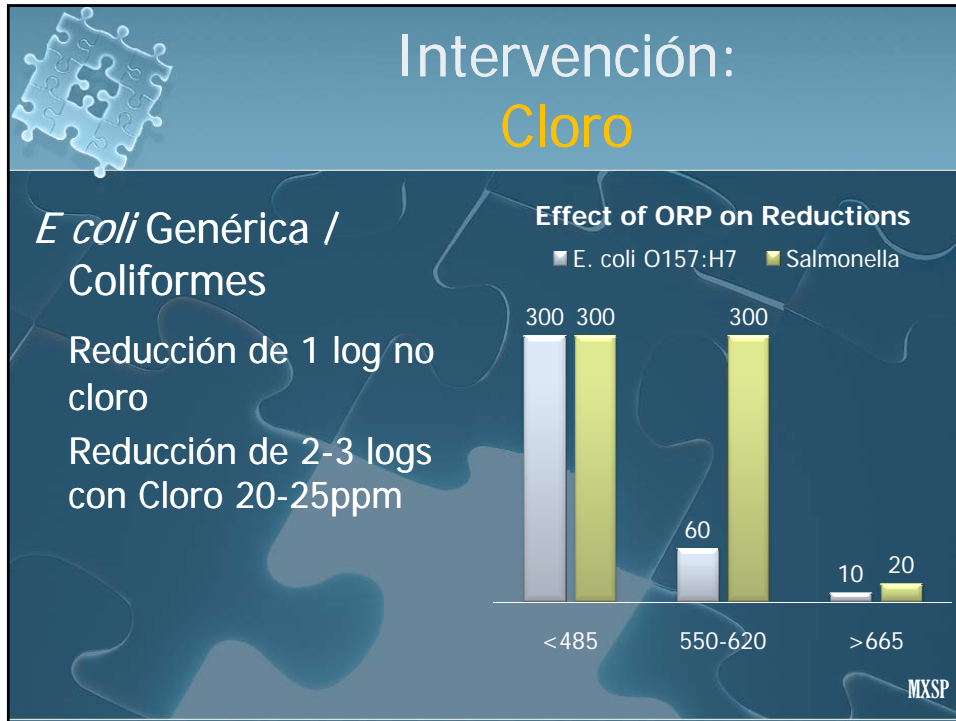
Se permite de 20–50 ppm en agua de chiller

Actua mejor a pH bajo 7, forma activa: HClO

ORP mayor a 665mv

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Intervenciones Pre-Chill : IOBW con Cloro

TABLE 2. Levels of bacteria in the whole carcass rinse of broiler carcasses before washing in the inside-outside bird washer¹

Bacteria	Control ²	Fecally contaminated control ³
Total Aerobic	4.6 ± 0.7	6.7 ± 0.5
<i>Escherichia coli</i>	3.6 ± 0.7	5.9 ± 0.2
<i>Salmonella</i>	NA	4.0 ± 0.7
<i>Campylobacter</i>	3.5 ± 0.8	6.3 ± 0.8

Norcutt et al., 2005

TABLE 3. Levels of bacteria in the whole carcass rinse of broiler carcasses after washing in an inside-outside bird washer¹ with 21.1, 43.3, or 54.4°C water containing 0 or 50 ppm chlorine

Bacteria	0 ppm Chlorine			50 ppm Chlorine		
	21.1°C	43.3°C	54.4°C	21.1°C	43.3°C	54.4°C
Total Aerobic	4.4 ± 0.1	4.6 ± 0.2	4.6 ± 0.2	4.4 ± 0.2	4.5 ± 0.2	4.6 ± 0.2
<i>Escherichia coli</i>	3.8 ± 0.1	4.1 ± 0.1	4.0 ± 0.2	3.8 ± 0.1	4.0 ± 0.2	3.9 ± 0.2
<i>Salmonella</i>	3.2 ± 0.2	3.3 ± 0.1	2.9 ± 0.2	3.1 ± 0.1	3.0 ± 0.2	2.9 ± 0.2
<i>Campylobacter</i>	3.5 ± 0.3	4.2 ± 0.2	3.9 ± 0.2	3.8 ± 0.2	3.8 ± 0.2	3.7 ± 0.2

¹Means for log₁₀ colony-forming units per milliliter of rinse ± standard error.

Intervenciones Pre-Chill

Table 5. Populations of *Campylobacter jejuni* survived on chicken surfaces after immersion only and the combinations of spraying and immersion treatment¹

Treatment	Surviving population (log ₁₀ cfu/g)
Immersion only	
Tap water	3.66 ^a
Chlorinated water	2.87 ^{bc}
Acidic EO water	2.59 ^c
Cross contamination on carcasses after immersion ²	
Tap water	3.50 ^a
Chlorinated water	2.94 ^{bc}
Acidic EO water	2.58 ^c
Combinations of spraying and immersion	
Tap water	3.59 ^a
Chlorinated water	2.63 ^c
Acidic EO water	2.88 ^{bc}
Cross contamination on carcasses after combinations of spraying and immersion ²	
Tap water	3.56 ^a
Chlorinated water	2.64 ^c
Acidic EO water	3.15 ^{ab}

^{a-c}Values with the same letter in the same column are not significantly different ($P > 0.05$).

¹Populations of *C. jejuni* on chicken carcasses before and after inoculation were 2.25 (control) and 4.92 log₁₀ cfu/g.

²Chicken carcass samples immersed in the treatment water along with inoculated carcasses to investigate any possible cross-contamination from inoculated samples.

Agua Electrolizada (EOW)

Kim et al., 2005

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Intervención: Dióxido de Cloro

"Aditivo Alimenticio Directo Secundario"

Espray, diluvio (deluge), inmersión
Pre y Post chiller
10 ppm max.

Chiller:
Residual no puede pasar de 3 ppm en agua del chiller

Aprobado como "Off Line Reprocessing" MXSP



Contajes de *E. coli* Generica

Log cfu/ ml de enjuague

Sánchez et al., 2007

TRT n=270	E	R	INT	C	P
Control	3.61 ^a	2.91 ^{bc}	2.91 ^{bc}	2.50 ^d	2.50 ^d
ASC	3.61 ^a	2.91 ^{bc}	2.21 ^{def}	2.10 ^{efg}	2.10 ^{efg}
Dioxide Pre-Chill	3.61 ^a	2.91 ^{bc}	2.96 ^{ab}	2.00 ^{efg}	2.00 ^{efg}
Dioxide Post-Chill	3.61 ^a	2.91 ^{bc}	2.91 ^{bc}	2.50 ^d	1.65 ^{fg}
Dioxide Pre Post	3.61 ^a	2.91 ^{bc}	2.96 ^{ab}	2.00 ^{efg}	1.57 ^g

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Contajes de Psicrótrofos
Log cfu/ ml de enjuague

Sánchez et al., 2007

TRT n=270	E	R	INT	C	P
Control	4.09 ^a	3.58 ^{abcd}	3.58 ^{abcd}	3.42 ^{bcde}	3.42 ^{bcde}
ASC	4.09 ^a	3.58 ^{abcd}	2.43 ^{ghi}	3.52 ^{bcde}	3.52 ^{bcde}
Dioxide Pre-Chill	4.09 ^a	3.58 ^{abcd}	3.71 ^{abc}	3.51 ^{bcde}	3.51 ^{bcde}
Dioxide Post-Chill	4.09 ^a	3.58 ^{abcd}	3.58 ^{abcd}	3.42 ^{bcde}	2.66 ^{ghif}
Dioxide Pre Post	4.09 ^a	3.58 ^{abcd}	3.71 ^{abc}	3.51 ^{bcde}	2.27 ^{hi}

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Prevalencia de *Salmonella* spp.
Porcentaje Muestras Positivas %

Sánchez et al., 2007

TRT n=540	E	R	INT	C	P
Control	46.7 ^{ab}	41.7 ^{ab}	41.7 ^{ab}	31.7 ^{abc}	31.7 ^{abc}
ASC	46.7 ^{ab}	41.7 ^{ab}	23.3 ^{bc}	30.0 ^{abc}	30.0 ^{abc}
Dioxide Pre-Chill	46.7 ^{ab}	41.7 ^{ab}	45.0 ^{ab}	43.3 ^{ab}	43.3 ^{ab}
Dioxide Post-Chill	46.7 ^{ab}	41.7 ^{ab}	41.7 ^{ab}	31.7 ^{abc}	38.3 ^{abc}
Dioxide Pre Post	46.7 ^{ab}	41.7 ^{ab}	45.0 ^{ab}	43.3 ^{ab}	15.0 ^{bc}

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Prevalencia de *Salmonella* spp.
 Porcentaje Muestras Positivas %
 Sánchez et al., 2007

TRT n=540	E			R			INT			C			P		
Control	85	50	5	80	45	0	80	45	0	60	20	15	60	20	15
ASC	85	50	5	80	45	0	60	10	0	60	20	10	60	20	10
Dioxide Pre-Chill	85	50	5	80	45	0	95	35	5	65	10	55	65	10	55
Dioxide Post-Chill	85	50	5	80	45	0	80	45	0	60	20	15	65	20	30
Dioxide Pre Post	85	50	5	80	45	0	95	35	5	65	10	55	15	15	15

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Intervención:
Clorito Acidificado de Sodio (ASC)

" Aditivo Alimenticio Directo Secundario "

Aprobado FDA 21 CFR sección 173.325

Espray o inmersión (Pre y Post Chiller):
 Concentración: 500–1,200 ppm clorito de sodio + ácido GRAS. pH Final : 2.3–2.9

Pre-chiller o chiller:
 Concentración: 50 –150 ppm clorito de sodio + ácido GRAS. Final pH 2.8–3.2

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Clorito Acidificado de Sodio (ASC)

Kemp et al., 2001

TABLE 1. Comparison of carcass microbiological quality postvisceration, post-COP, and post-OLR

Organism	n	Postvisc	n	Post-COP	n	Post-OLR
<i>E. coli</i> (log ₁₀ CFU/ml)	890	2.87 A ^a	1,070	0.59 c	1,070	2.37 B
<i>Campylobacter</i> (log ₁₀ CFU/ml)	62	3.70 A	144	1.14 c	69	2.89 B
<i>Salmonella</i> (%)	888	31.3 A	1,070	10.0 c	1,069	31.6 B
<i>Campylobacter</i> (%)	246	73.2 A	230	49.1 B	250	73.2 A

^a Letters that differ within rows designate values that are significantly different.

TABLE 2. Comparison of carcass microbiological quality postwash and post-OLR

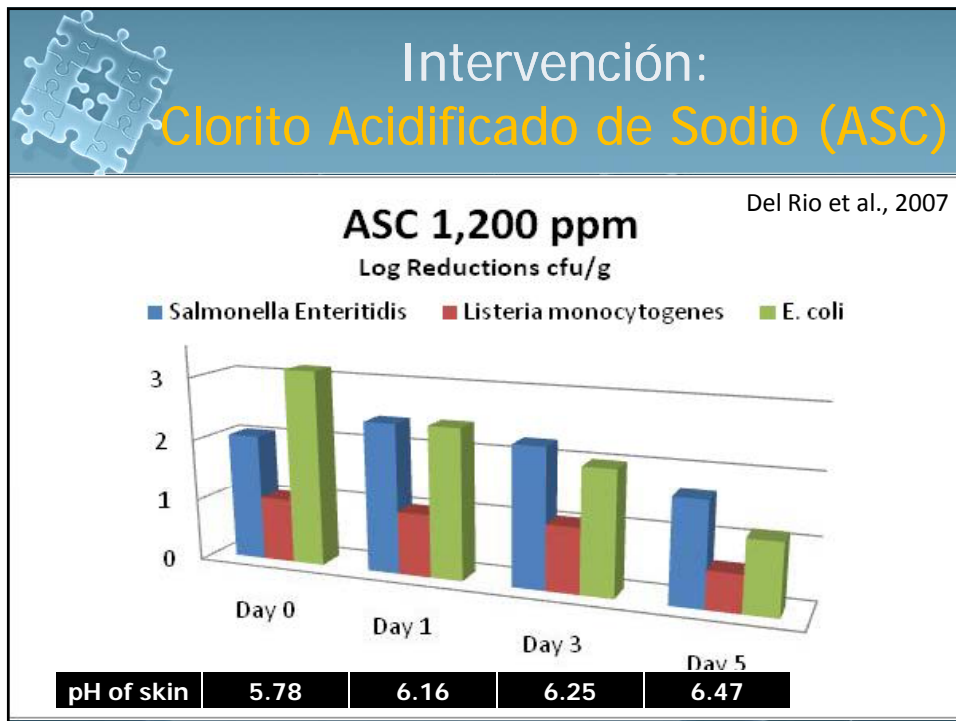
Organism	n	Postwash	n	Post-OLR
<i>E. coli</i> (log ₁₀ CFU/ml)	1,068	2.27 B ^a	1,070	2.37 A
<i>Campylobacter</i> (log ₁₀ CFU/ml)	149	2.62	69	2.89
<i>Salmonella</i> (%)	1,070	31.4	1,069	31.6
<i>Campylobacter</i> (%)	230	74.8	250	73.2

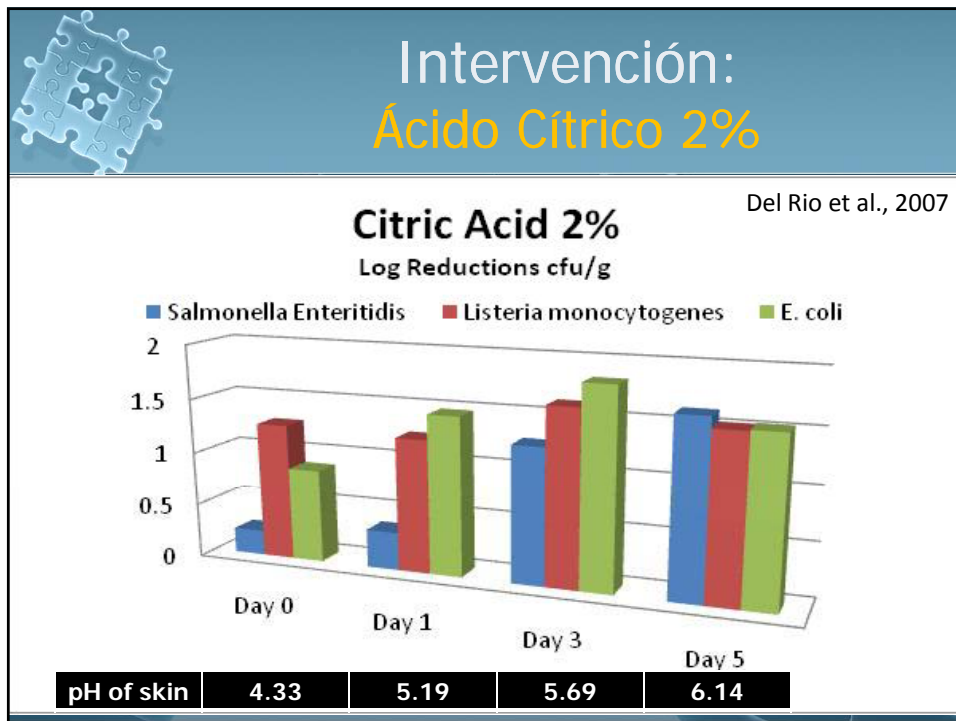
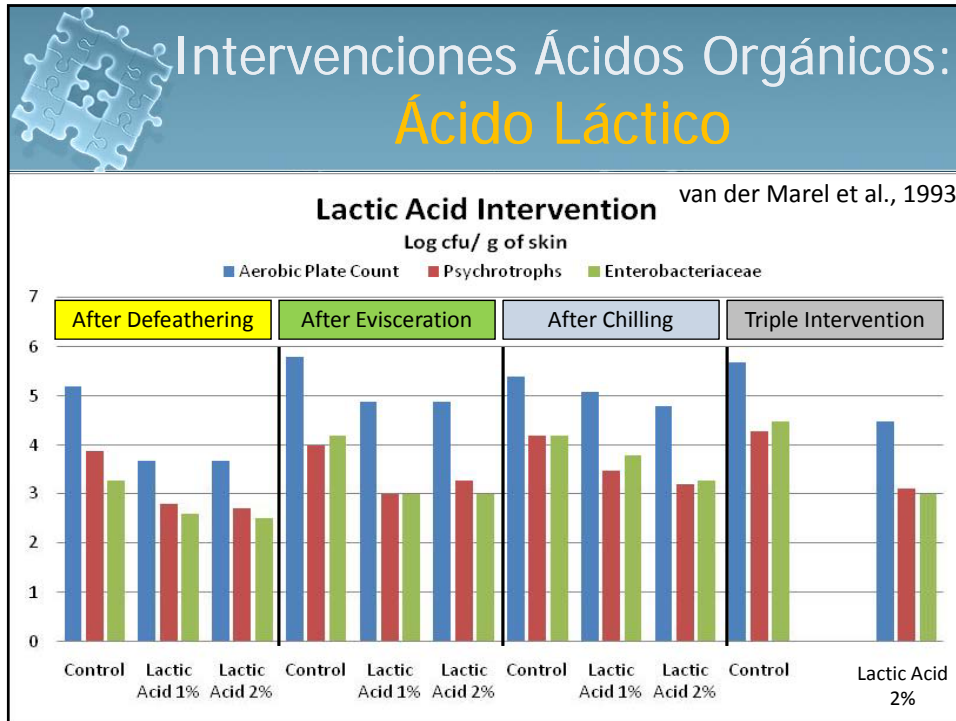
^a Letters that differ within rows designate values that are significantly different.

TABLE 3. Comparison of carcass microbiological quality post-COP and postchill

Organism	n	Post-COP	n	Postchill
<i>E. coli</i> (log ₁₀ CFU/ml)	1,070	0.59 B ^a	160	0.84 A
<i>Campylobacter</i> (log ₁₀ CFU/ml)	144	1.14 B	103	0.64 A
<i>Salmonella</i> (%)	1,070	10.0	160	12.5
<i>Campylobacter</i> (%)	230	49.1	203	57.6

^a Letters that differ within rows designate values that are significantly different.







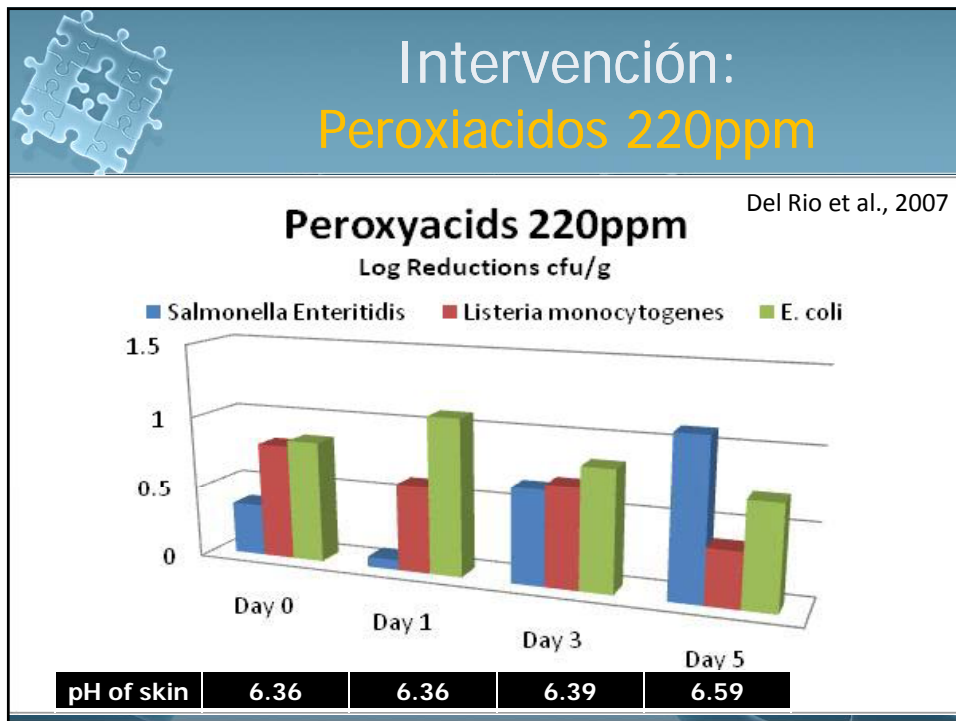
Intervención:
Ácido Peracético (Peroxiacético)

"Aditivo Alimenticio Directo Secundario"

Aprobado FDA 21 CFR sección 173.37
 Espray, diluvio (deluge), inmersión
 Máxima concentración

- 220 ppm ácido peracético
- 110 ppm peróxido de hidrogeno
- 13 ppm ácido 1-hidroxiyetilideno-1,1-difosfonico

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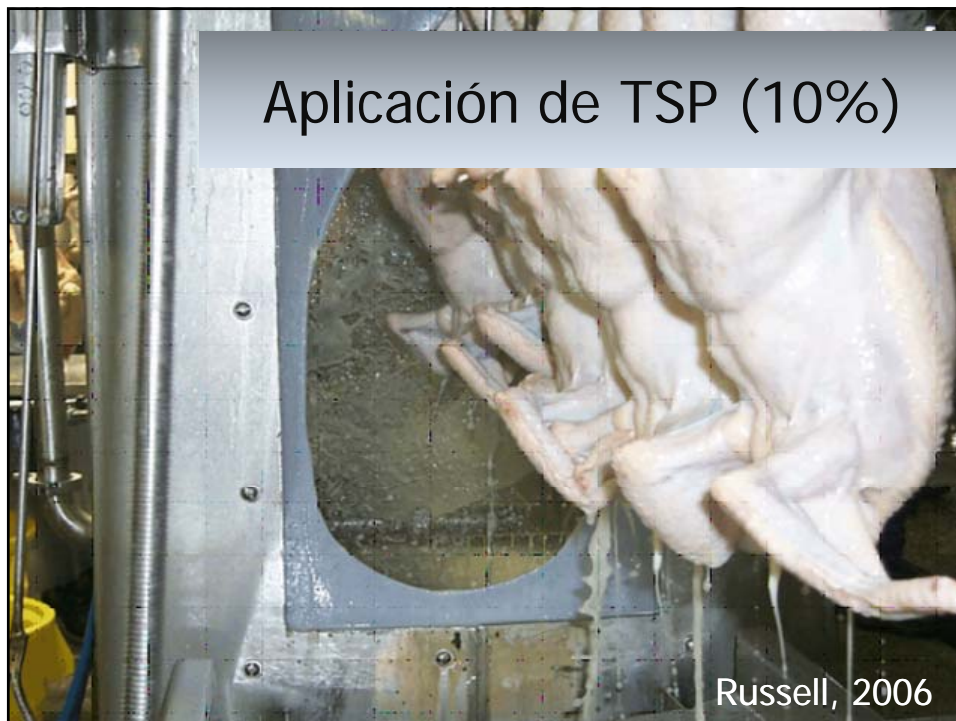




 Intervención:
Fosfato Trisódico

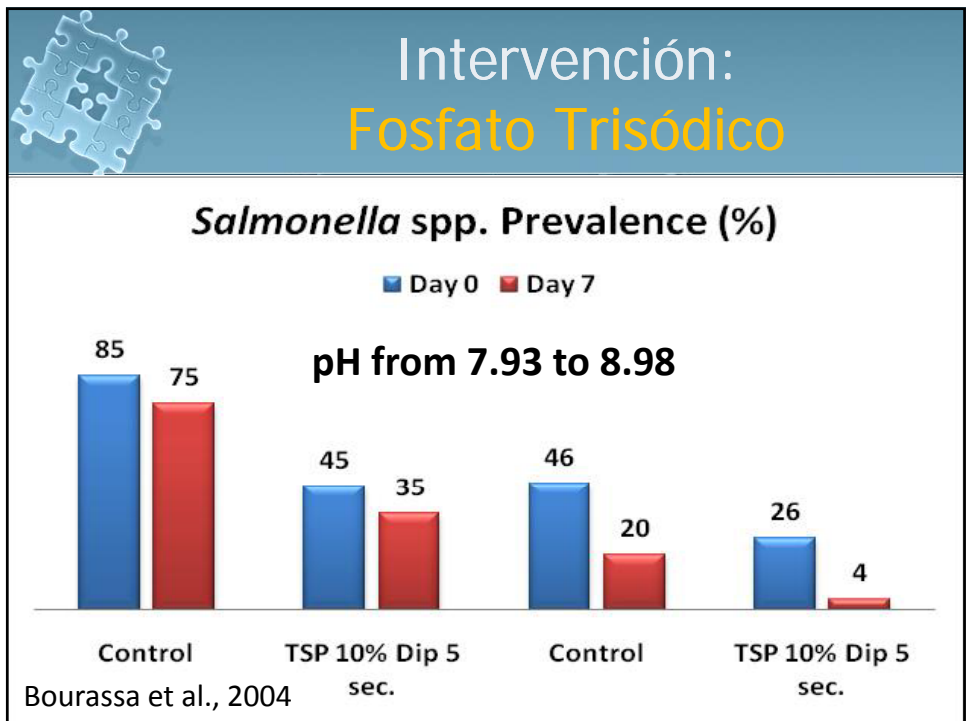
GRAS "*Generally Recognized As Safe*"
Aprobado FDA CFR sección 182.1778
Espray, diluvio (deluge), inmersión
Concentración:
8–12%
Aplicado en espray con 20 ppm de cloro
Aplicado en canales pre-chill por 15 s

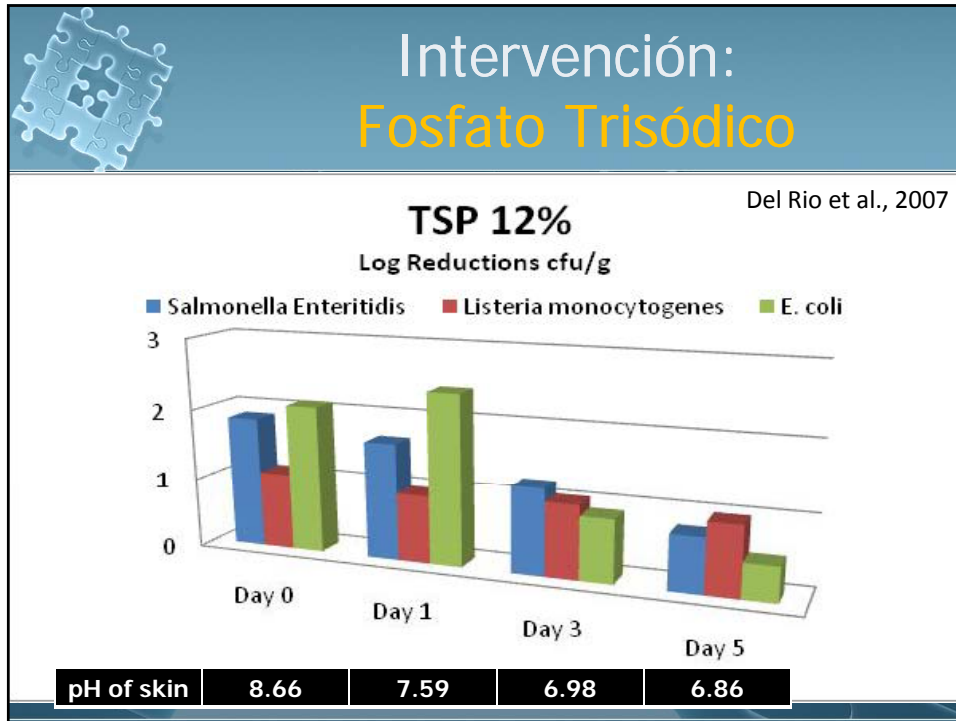
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Treatment	Reduction	Reference
Dip: 10% TSP, 15 s, 50 °C	<limit of detection in 72 or 4-36% samples (depending on a nitrocellulose membrane lift or a conventional culture method are used for determination)	Slavik et al. (1994)
Dip: 10% TSP, 15 s, 10 °C	0.16 log ₁₀ (P > 0.1)	
Dip: 10% TSP, 15 s, 50 °C	1.2-1.5 log ₁₀ after 1-6 days of storage at 4 °C	
Dip: 10% TSP, 15 s, 16-20 °C	1.3 log ₁₀	Federighi et al. (1995)
Dip: 10% TSP, 15 s	100%	Colin and Salvat (1996)
AvGard [®] procedure	<limit of detection in 100% of samples	Salvat et al. (1997)
Dip: 10% TSP, 15 s	1.71 log ₁₀	Whyte et al. (2001)





Intervención: Cloruro de Cetilpiridinio (CPC)

"Aditivo Alimenticio Directo Secundario"

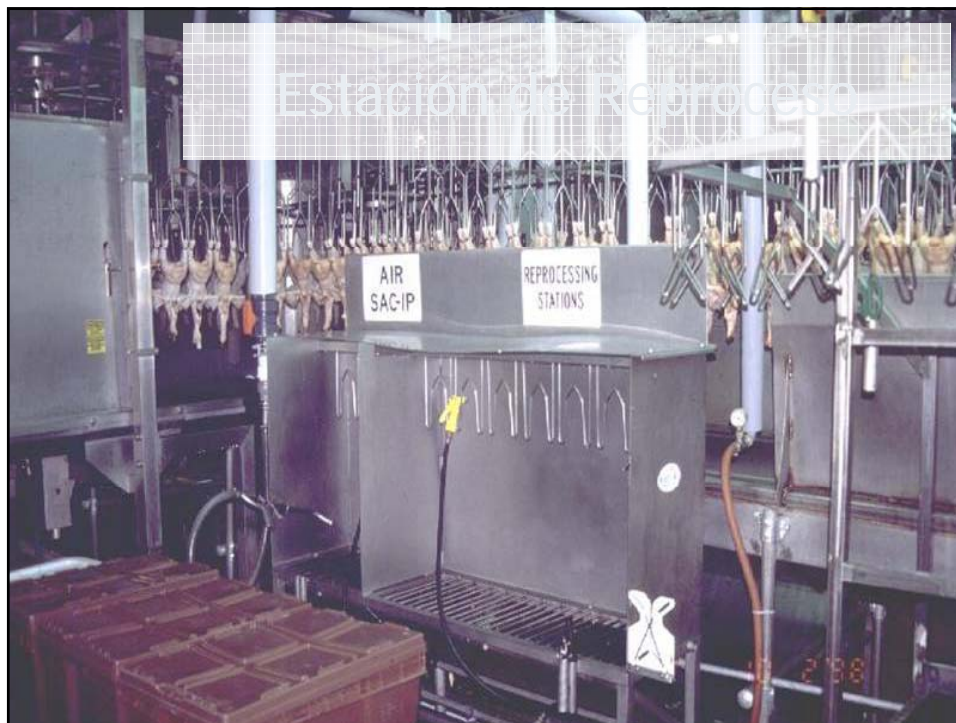
Aprobado FDA 21 CFR sección 173.375
 Hasta 0.8%
 Inaceptable sobre 0.3 g/lb de pollo
 La concentración de propilen glicol es 1.5 veces la concentración de CPC
 Espray, deluge o inmersión
 Chiller
 Aplicación post-chiller:
 inmersión, deluge

MXSP



Intervención: Agua Ozonada

GRAS "*Generally Recognized As Safe*"
Aprobada FDA 21 CFR sección 184.1563
Espray, deluge, inmersión
Agente Antimicrobiano; 21 CFR 170.3(o)(2),d
Puede usarse en fase gaseosa
o acuosa

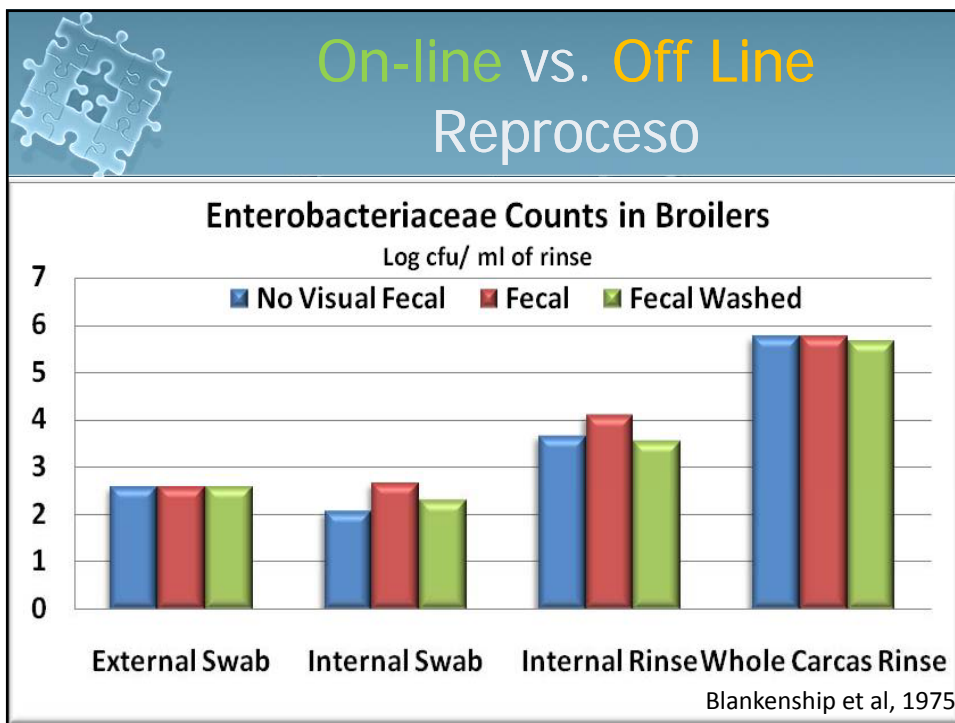


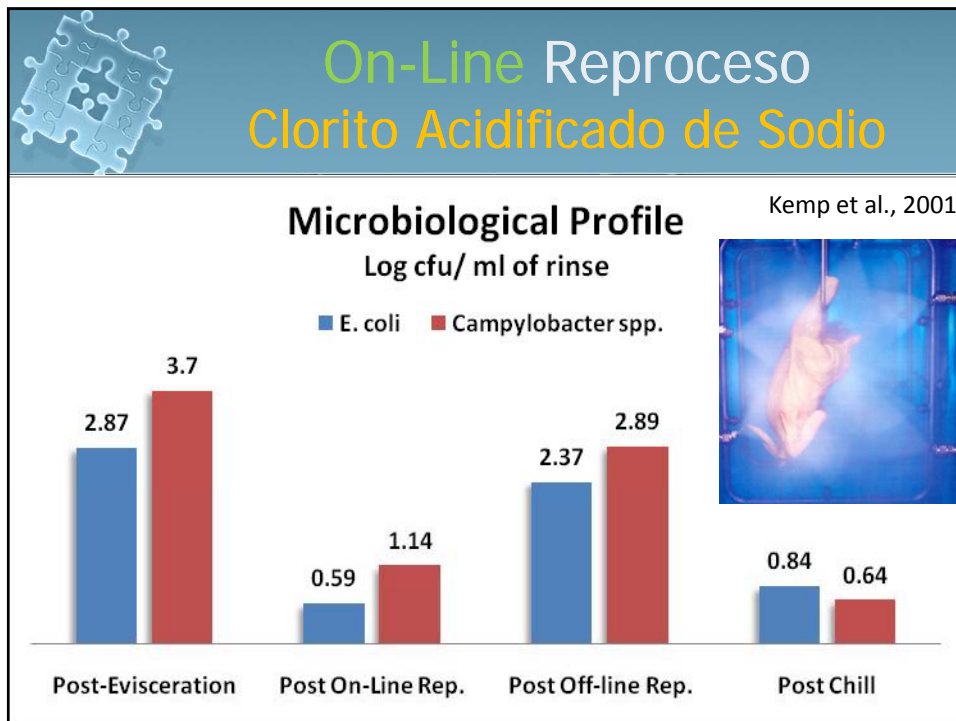
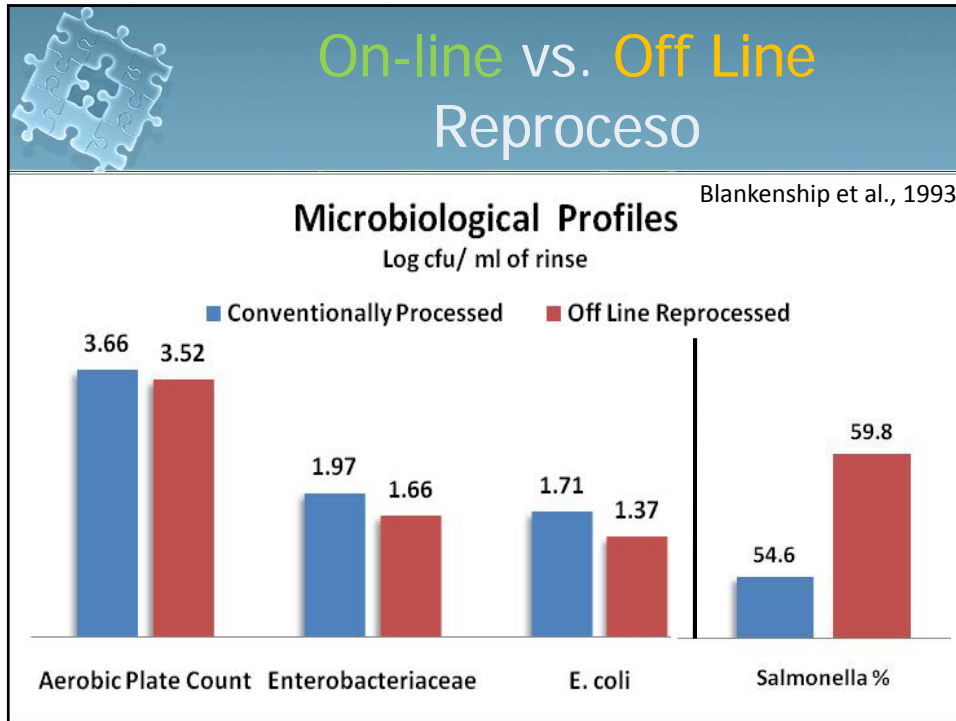


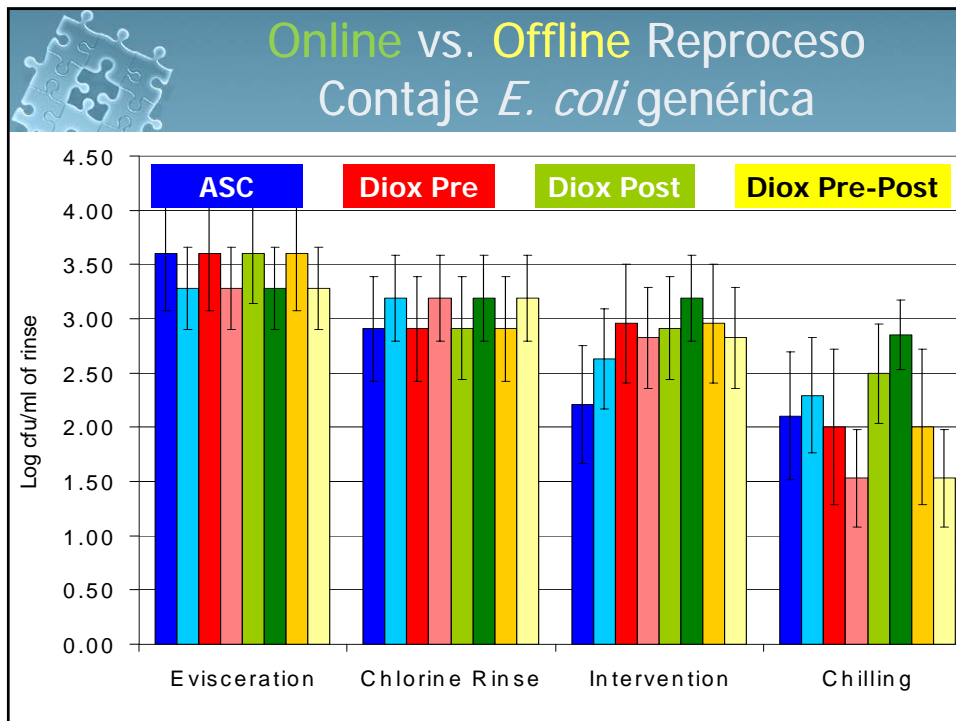
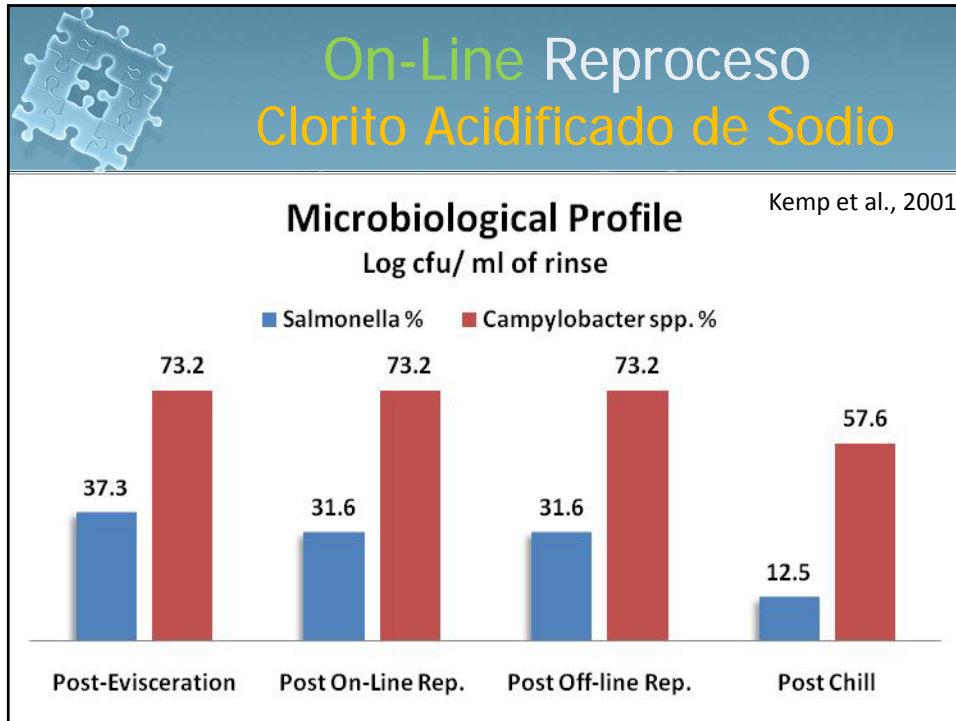
Reprocesamiento En Línea On Line Reprocessing (OLR)

0.5-1% de la producción se destina a Offline Reprocessing
Cambio en 1989

- Cortes
- Succión (vacio)
- Lavado
 - 20 ppm cloro
- Combinaciones
- Antimicrobianos



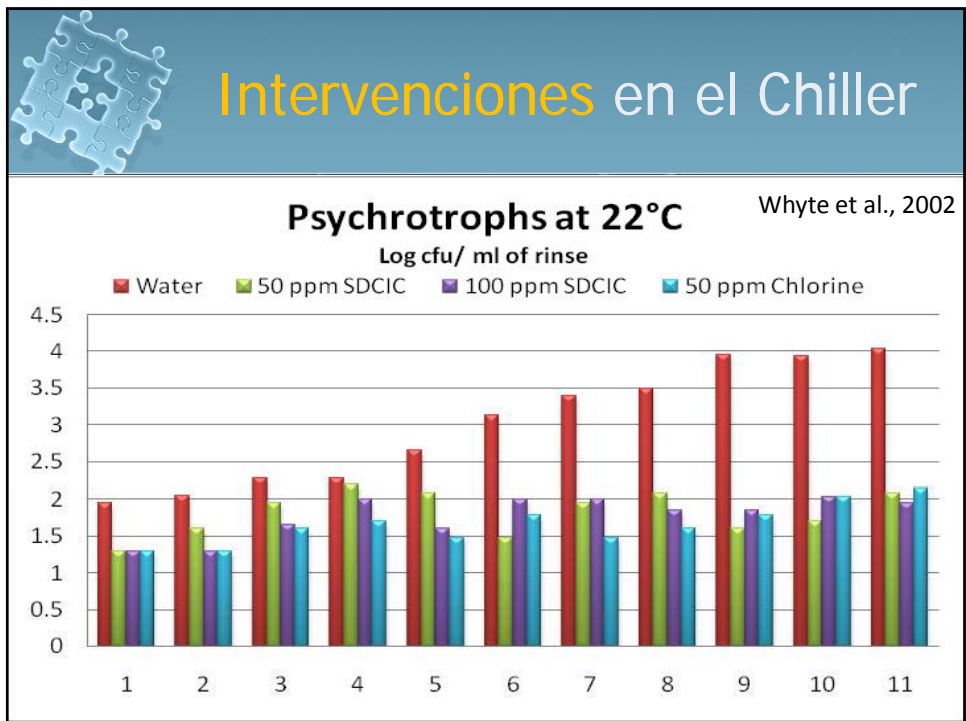
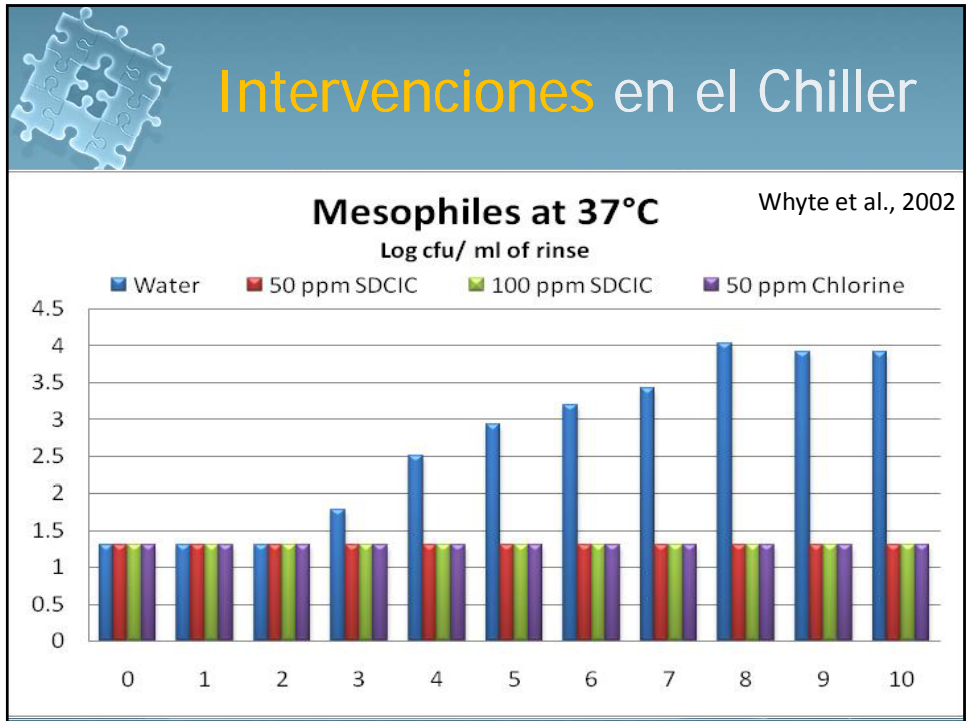


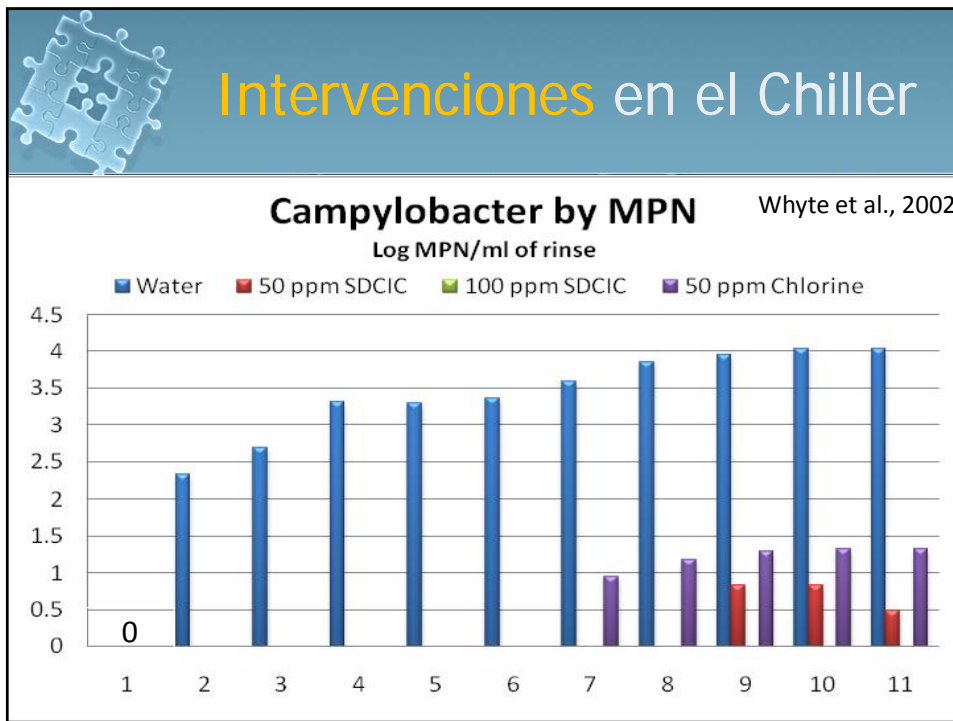
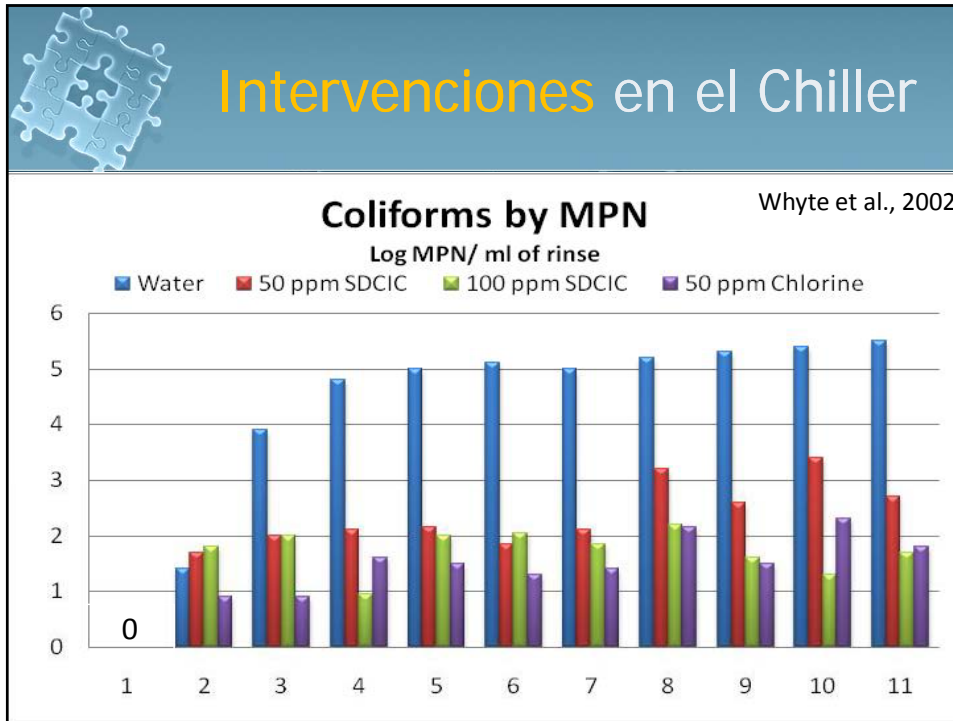


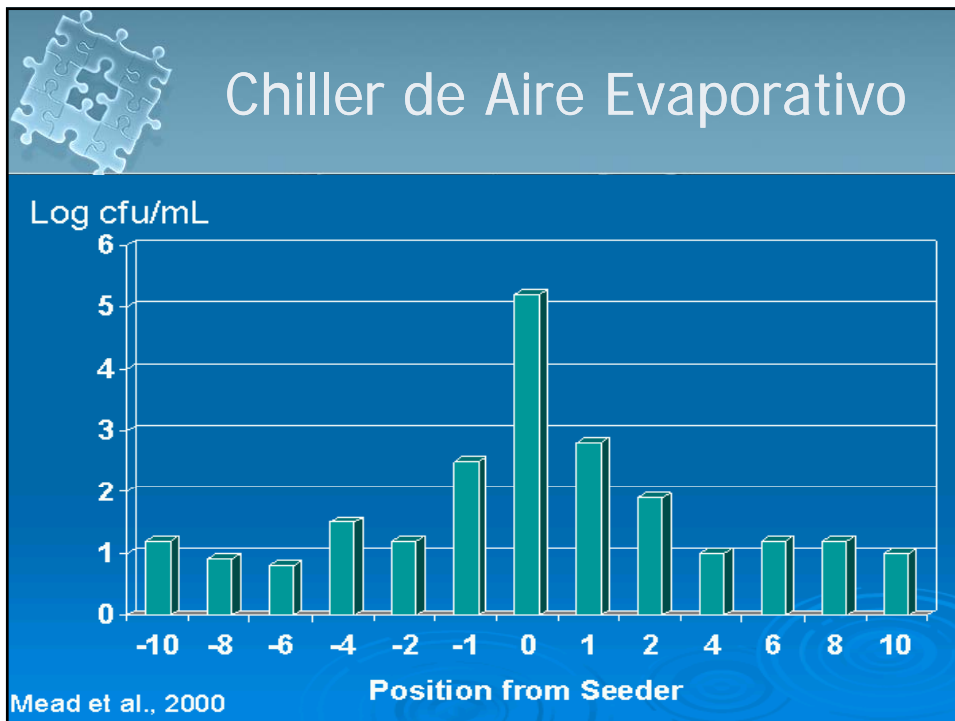
 **Intervenciones** en el Chiller

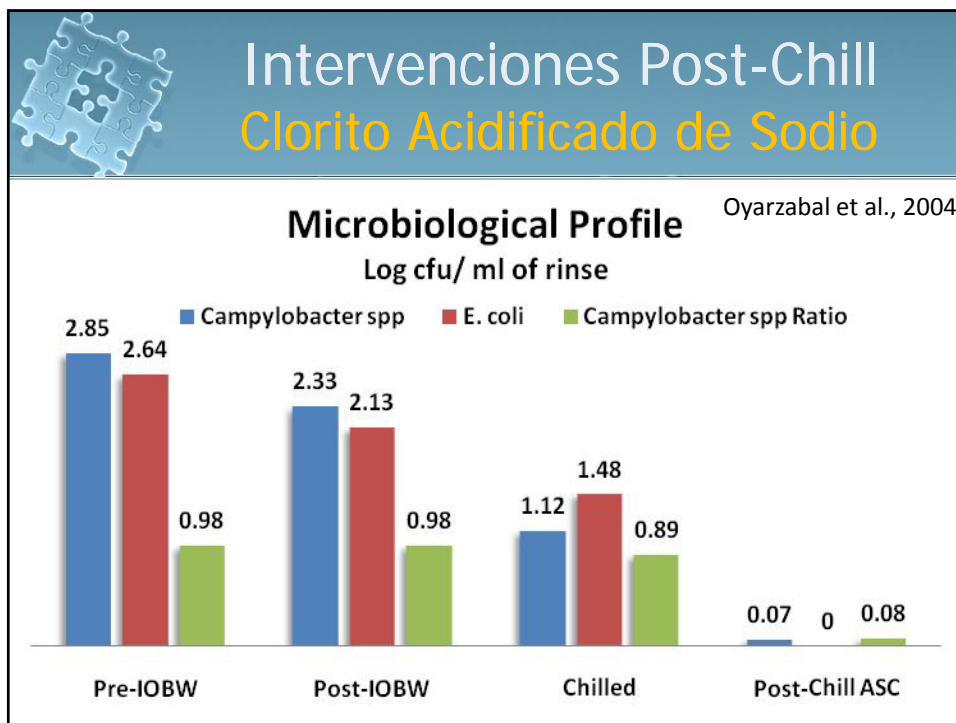
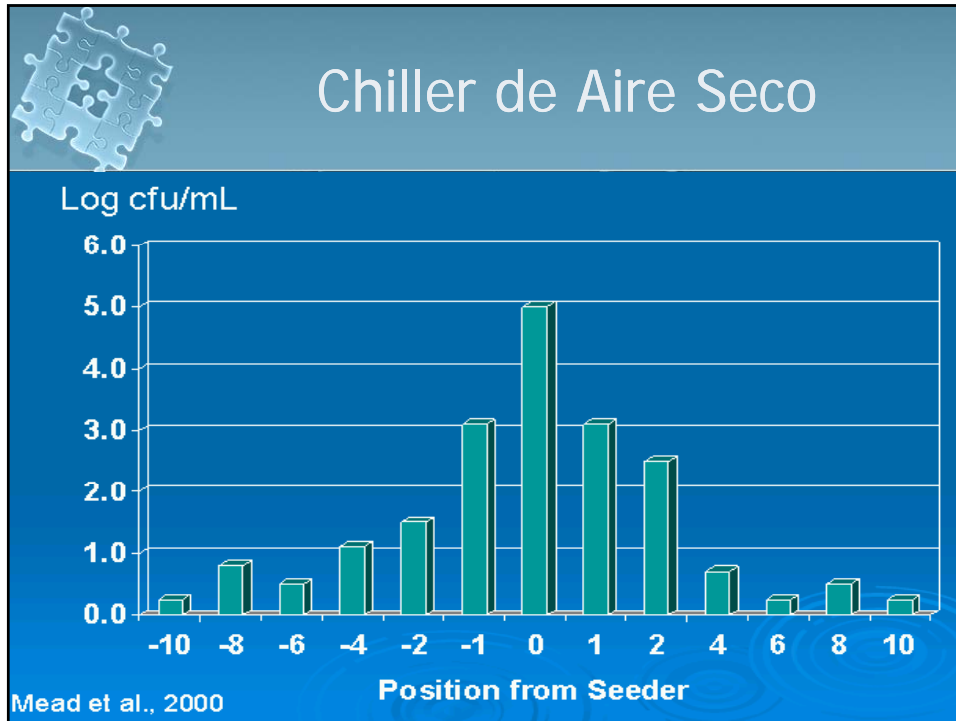
Reflujo de agua (1/2 litro)
Calidad del agua
Temperatura
pH 6.5 a 7.5
ORP: 650-700mV
Cloro libre:
 1-5 ppm en sobreflujo (Waldroup)
Reducir material orgánico
Contra corriente
Limpieza
Jets

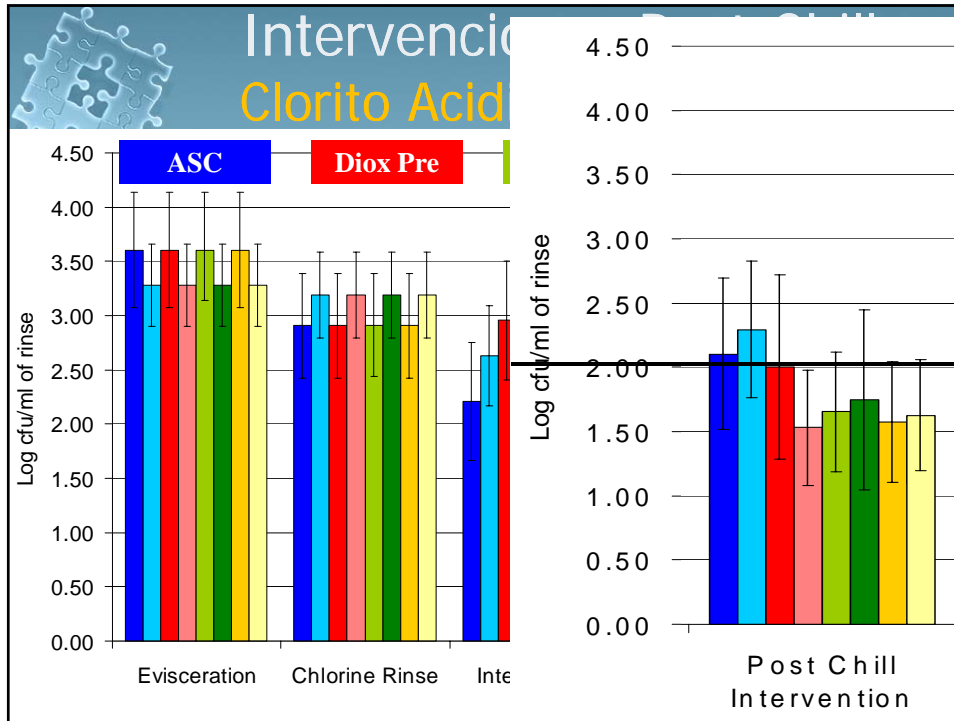










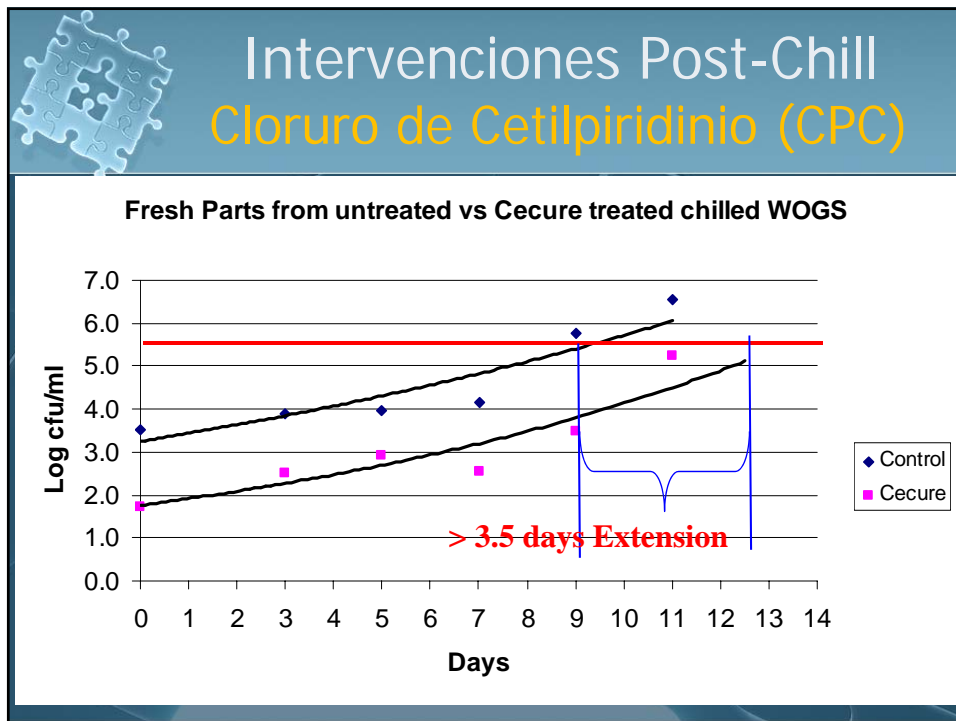
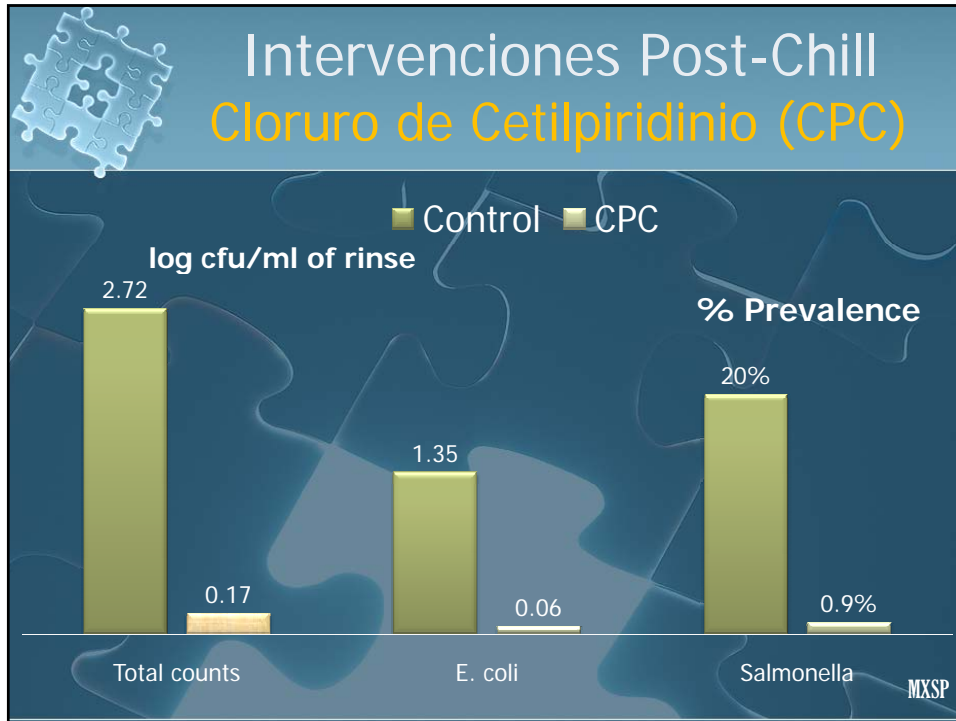


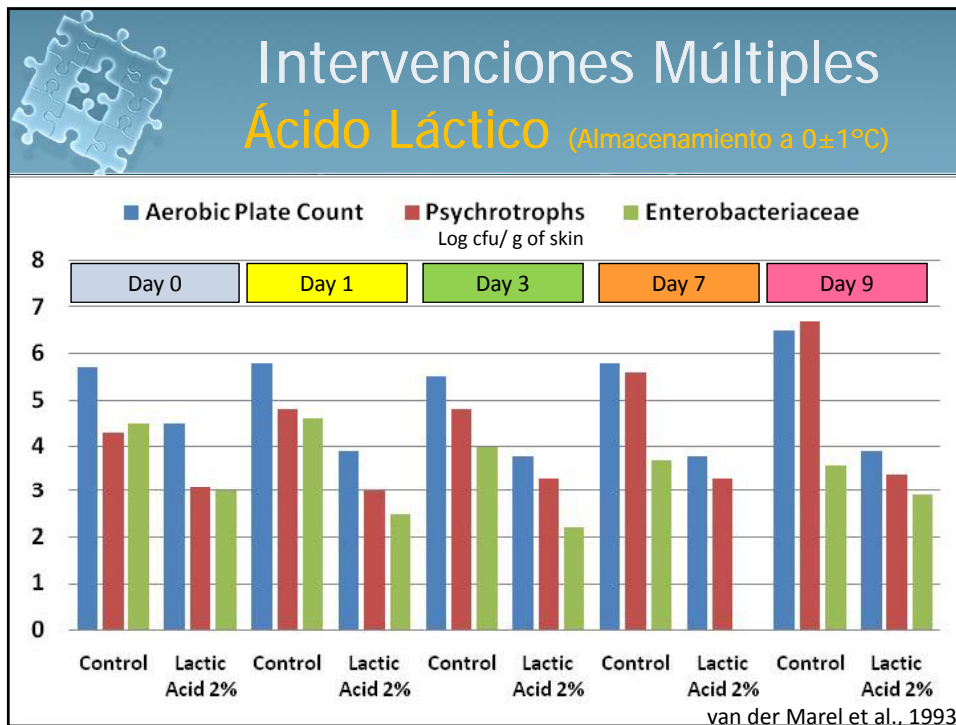
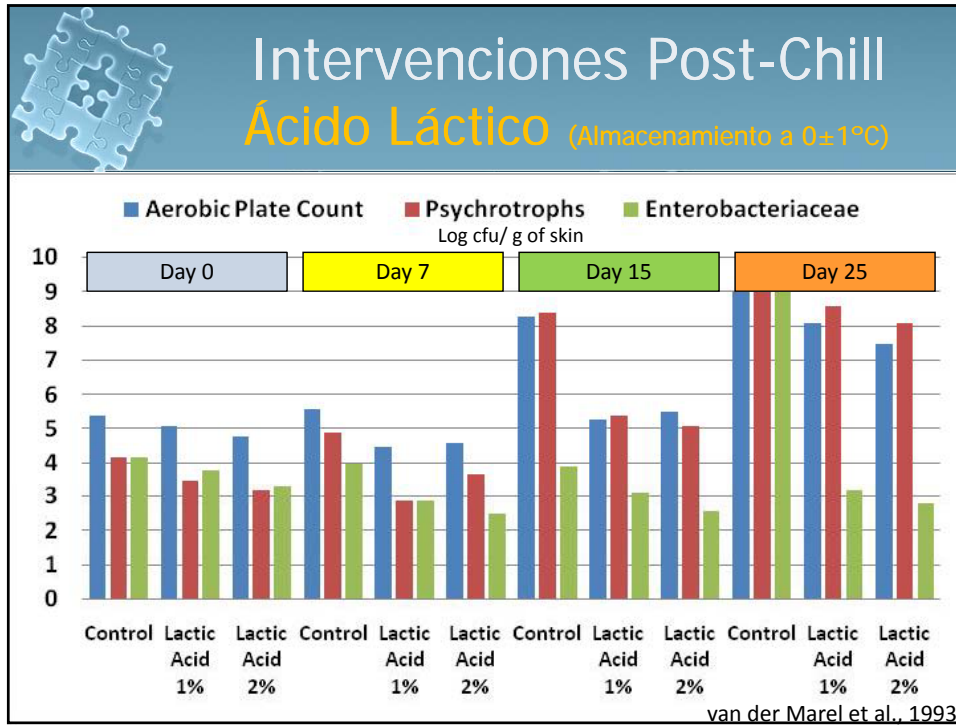
Contaje de Psicrotrofos

Log cfu/ ml of rinse Sánchez et al., 2007

TRT n=270	E	R	INT	C	P
Control	4.09 ^a	3.58 ^{abcd}	3.58 ^{abcd}	3.42 ^{bcde}	3.42 ^{bcde}
ASC	4.09 ^a	3.58 ^{abcd}	2.43 ^{ghi}	3.52 ^{bcde}	3.52 ^{bcde}
Dioxide Pre-Chill	4.09 ^a	3.58 ^{abcd}	3.71 ^{abc}	3.51 ^{bcde}	3.51 ^{bcde}
Dioxide Post-Chill	4.09 ^a	3.58 ^{abcd}	3.58 ^{abcd}	3.42 ^{bcde}	2.66^{ghif}
Dioxide Pre Post	4.09 ^a	3.58 ^{abcd}	3.71 ^{abc}	3.51 ^{bcde}	2.27^{hi}

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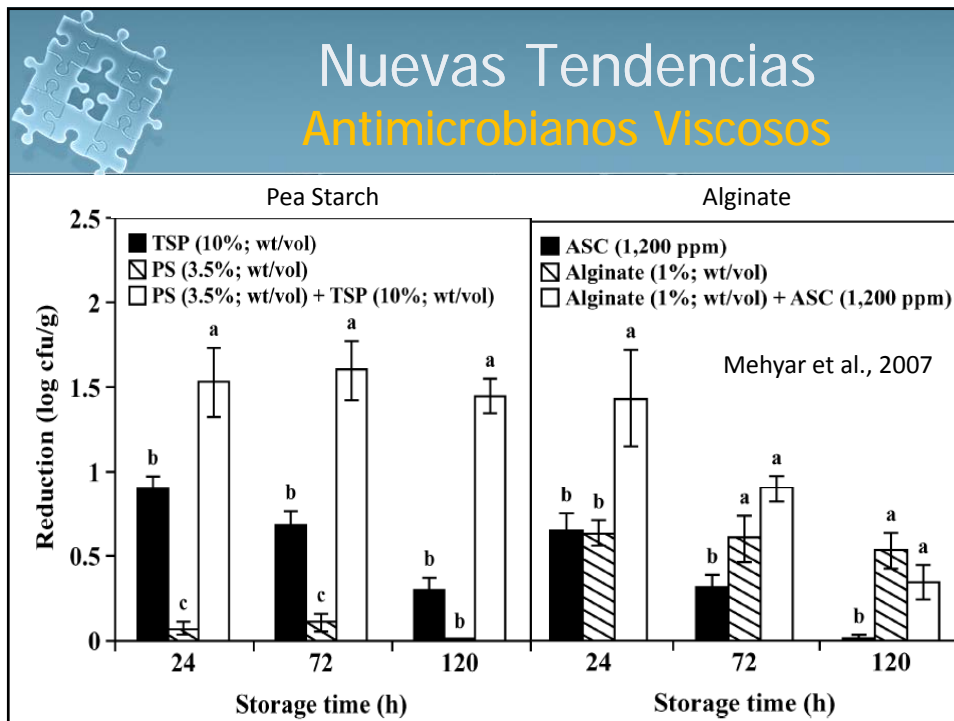


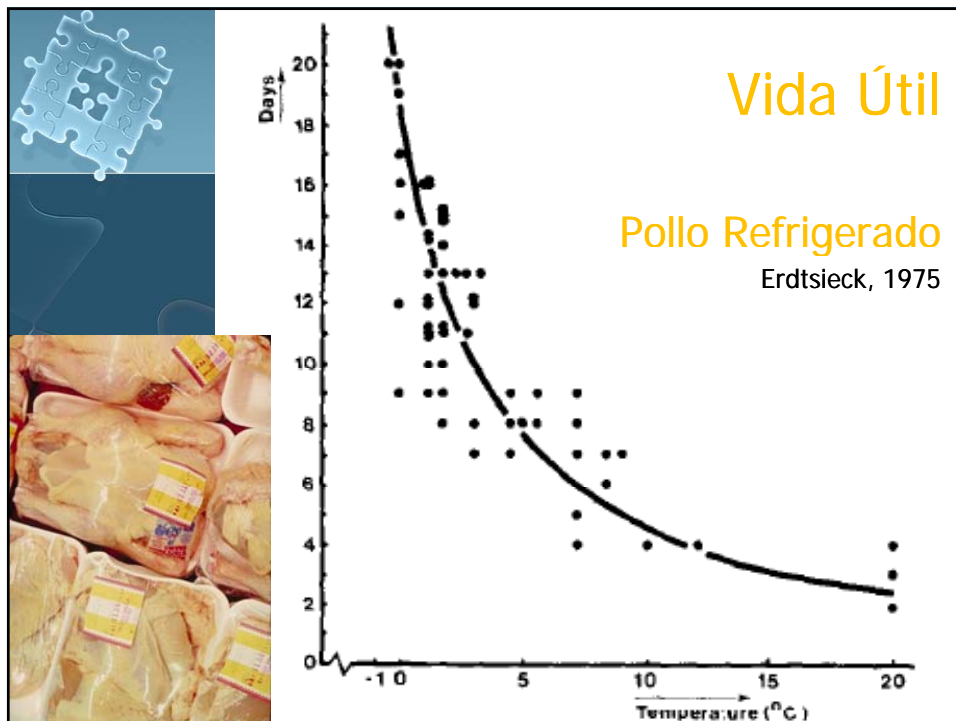
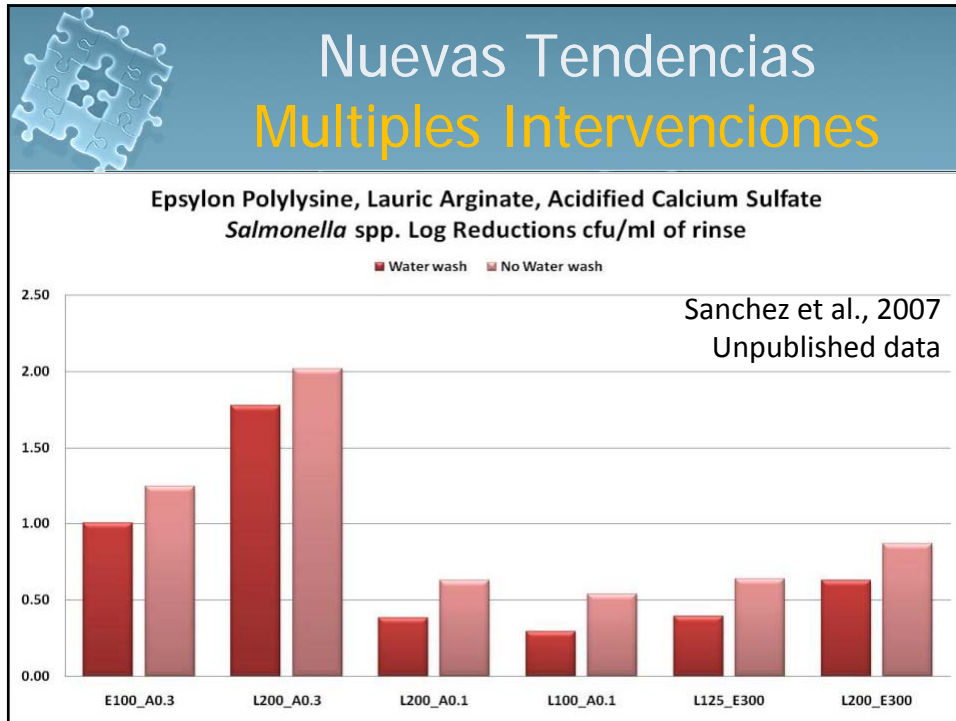
Intervenciones Múltiples

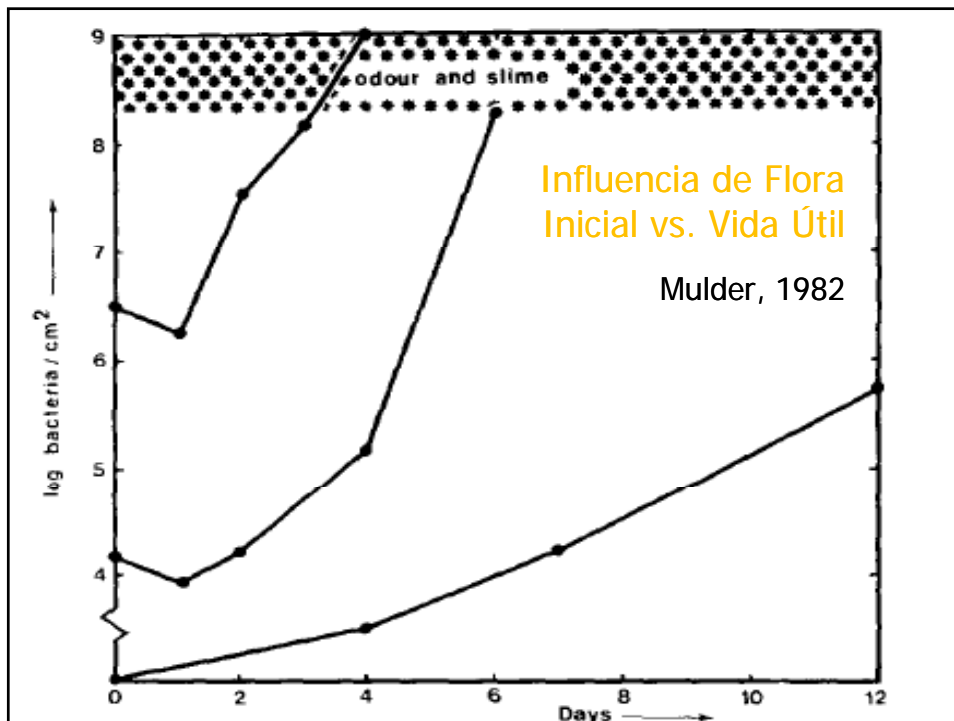
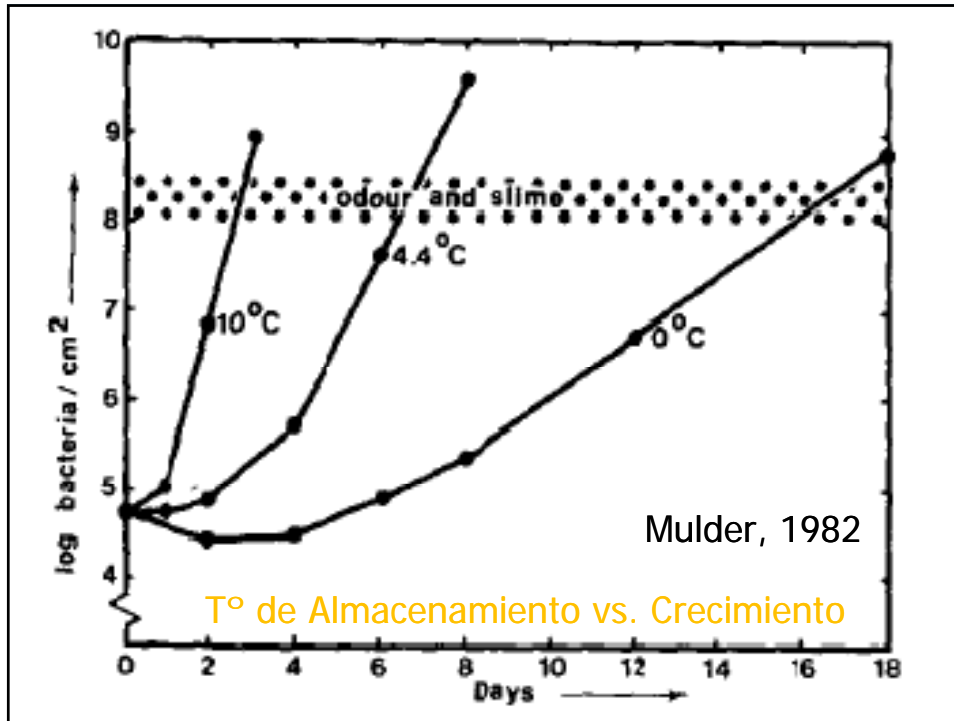
TABLE 2. Microbial populations and Salmonella incidence for carcasses before (Pre) and after (Post) interventions^a

Intervention	Stage	Mean (SD) counts (log CFU/ml)			Salmonella incidence (%)
		Aerobic plates	Total coliforms	<i>E. coli</i>	
New York wash	Pre	4.5 (0.5) A	3.3 (0.8) A	3.1 (0.8) A	34 A
	Post	4.3 (0.4) B	3.1 (0.7) A	2.9 (0.8) A	26 B
Postevisceration wash	Pre	3.9 (0.5) A	2.8 (0.8) A	2.6 (0.8) A	45 A
	Post	4.0 (0.7) A	3.1 (0.9) A	2.8 (1.0) A	36 B
Inside-outside bird wash 1 (IOBW1)	Pre	3.8 (0.5) A	2.8 (0.7) A	2.5 (0.7) A	25 A
	Post	3.7 (0.7) A	2.5 (0.9) B	2.2 (0.9) B	20 A
Inside-outside bird wash 2 (IOBW2)	Pre	3.7 (0.6) A	2.5 (0.9) A	2.3 (0.9) A	16 A
	Post	3.4 (0.7) B	2.2 (0.9) B	2.0 (1.1) B	12 A
Chlorine dioxide wash	Pre	3.2 (0.5) A	2.2 (0.8) A	1.9 (0.9) A	17 A
	Post	3.0 (0.5) B	1.8 (0.9) B	1.5 (1.0) B	9 B
Trisodium phosphate wash	Pre	3.6 (0.5) A	2.3 (0.6) A	2.0 (0.6) A	10 A
	Post	3.1 (0.6) B	1.5 (0.7) B	1.3 (0.7) B	3 B
Chlorine chiller	Pre	3.3 (0.6) A	1.6 (0.6) A	1.3 (0.6) A	5 A
	Post	2.8 (0.6) B	1.2 (0.6) B	1.0 (0.6) B	7 A
Chlorine dioxide plus chlorine chiller	Pre	3.1 (0.5) A	1.7 (0.8) A	1.4 (0.9) A	4 A
	Post	1.9 (0.5) B	0.7 (0.4) B	0.6 (0.4) B	14 B
Chiller exit spray	Pre	2.1 (0.5) A	<0 ^b	<0 ^b	8 A
	Post	2.3 (0.5) B	<0 ^b	<0 ^b	8 A
Postchiller wash	Pre	2.3 (0.4) A	1.1 (0.6) A	0.9 (0.6) A	10 A
	Post	2.1 (0.4) B	0.9 (0.6) B	0.6 (0.5) A	4 A
Dropped carcass wash	Pre	3.1 (0.9) A	1.0 (0.6) A	0.5 (0.5) A	16 A
	Post	2.7 (0.6) B	1.0 (0.6) A	0.3 (0.5) B	8 B

^a Within each intervention, Pre and Post values followed by different letters are significantly different at $\alpha = 0.05$.
^b Limit of detection.










Conclusiones

Pros	Contras
Reducir patógenos	Costoso
Aumentar vida útil	Efectos organolépticos
Cumplir regulaciones	Uso de agua
Mejor calidad	Disposición
Control HACCP	Aplicación
Consistencia	Tiempo de contacto
	Salud de empleado

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Preguntas?

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TABLE 1. Commercial antimicrobials commonly used by the poultry industry to reduce *Campylobacter* spp. during processing

Antimicrobial	FDA approval (21 CFR section)	Use	Suggested mode of action
Acidified sodium chlorite ^a	173.325	Spray or dip solution: 500–1,200 ppm sodium chlorite and any GRAS acid to achieve a pH of 2.3–2.9; prechiller or chiller solution: 50–150 ppm sodium chlorite and any GRAS acid to achieve a pH of 2.8–3.2	Broad-spectrum germicides; oxychlorous compounds act by breaking bonds on cell membrane surfaces
Cetylpyridinium chloride ^a	173.375	Not to exceed 0.3 g/lb of poultry, propylene glycol concentration 1.5 times that of cetyl pyridinium chloride	Hydrophilic portion reacts with the cell membrane, resulting in the leakage of the cellular components, disruption of cell metabolism, and ultimate cell death
Chlorine (sodium hypochlorite) ^{b,c}		20–40 ppm in chill water; also used in processing water at 10–30 ppm	Oxidation of cell components resulting in cell death
Chlorine dioxide ^a	173.3	Not to exceed 3 ppm in poultry process water contacting whole fresh carcasses	Oxidation of the cellular membrane and cellular constituents; at high concentrations, it breaks the cell wall
Ozone ^b	184.1563	Antimicrobial agent as stated in 21 CFR 170.3(o)(2); ^d used in gaseous or aqueous phases	Direct molecular reaction and indirect reactions involving free radicals, oxidation of cell membrane
Peroxyacetic acid ^a	173.37	Maximum concentration of 220 ppm peroxyacetic acid, 110 ppm hydrogen peroxide, and 13 ppm 1-hydroxyethylidene-1,1-diphosphonic acid	Strong oxidation of cell membrane and other cell components, resulting in cell death
Trisodium phosphate ^b	182.1778	8–12% solution in conjunction with a water spray containing 20 ppm chlorine; solution can be applied by spraying or dipping chilled or prechilled carcasses for up to 15 s	Disruption of cell membrane causing leakage of intracellular fluid; details of the antimicrobial mechanism have not been completely elucidated

^a Secondary direct food additives.
^b Generally recognized as safe (GRAS).
^c FSIS considers the application of up to 30 ppm of chlorine on poultry to be sanctioned under the food additive provisions of the Federal Food, Drug and Cosmetic Act (2).
^d Antimicrobial agents: substances used to preserve food by preventing growth of microorganisms and subsequent spoilage.