Systematic review and meta-analysis of the impact of decontamination interventions on the prevalence and concentration of *Salmonella* in broiler chickens during primary processing

Section A: PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist

Section and topic Item No		Checklist item	Remark
Administrative Information			
Title: Identification	1a	Identify the report as a protocol of a systematic review	Protocol for a new systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	Not applicable
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	Protocol not registered as the systematic review does not directly refer to publications on human health
Authors Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	Josphat Njenga Gichure [1], Ranil Coorey [2], Patrick Murigu Kamau Njage [3], Joseph M. Wambui [4], Gary A. Dykes [5], Elna M. Buys [1*] [1]Department of Consumer and Food Sciences, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa; jngichure@gmail.com ORCID 0000-0002-1690-2354; elna.buys@up.ac.za ORCID 0000-0001-7836-9295 [2]School of Molecular and Life Sciences, Faculty of Science and Engineering, Curtin University, GPO Box U1987, Perth 6845, Australia; r.coorey@curtin.edu.au; ORCID 0000-0002-5261-1300 [3]Division for Epidemiology and Microbial Genomics, National Food Institute, Technical University of Denmark, Søltofts

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Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	Conceptualization: JG, EB, PKN, GD, RC; Methodology: JG, EB, PKN, GD, RC; Investigation: JG, PKN, JW; Resources: JG, EB, PKN, GD, RC; Data curation: JG, PKN, JW; Writing—original draft preparation: JG; Writing—review and editing: JG, EB, PKN, GD, JW, RC.
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	In case the protocol needs to be amended, the description of the amendment shall be dated and submitted with the rationale.
Support: Sources	5a	Indicate sources of financial or other support for the review	Australia Awards Africa postdoctoral scholarship University of Pretoria Postdoctoral scholarship
Sponsor	5b	Provide name for the review funder and/or sponsor	Australia Awards Africa postdoctoral scholarship University of Pretoria Postdoctoral scholarship
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	The funder had no other role in developing the protocol
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	Systematic review and meta-analysis aggregate quantitative data from different studies into unified effect size estimates with better statistical power in risk assessment model parameterization. This study uses

			systematic review and meta-analysis to estimate *Salmonella* decontamination during broiler slaughter from scalding to post-chilling, with meta-regression applied to explore modifier variables.
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	This study aims to aggregate evidence from eligible studies into unified summary estimates for *Salmonella* decontamination interventions during broiler chicken slaughter process from scalding to post-chilling using systematic review and meta-analysis and validate the impact of modifier variables using meta-regression.
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	Screening and inclusion based on PICO guidelines as per the following criteria: Study designs: for inclusion, randomized controlled, challenge trials, and before-after-trials. Participants: broiler chicken carcass from scalding to post-chill. Interventions: microbial and physical decontamination interventions examining the effect on *Salmonella* concentration and prevalence. Comparators: Interventions were grouped based on prevalence or concentration studies. Outcomes: the decrease/increase in concentration and/or prevalence before and after an intervention Timing: only samples collected from the same lot were evaluated. Setting: actual slaughterhouse or pilot plants. Language- English
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	The search was in five electronic databases namely; (i) Dimensions, (ii) Web of Science, (iii) PubMed, (iv) African Index Medicus and (v) Google Scholar Only literature published between 01/01/1998 and 30/09/2022 were included. Handsearching through scanning the reference lists of the included studies and existing reviews was conducted to complement the electronic database search.

Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	Publications on qualitative and quantitative trials were identified. No restrictions were made on the design or language at this point. Google translate was used in case the title was in a non-English language. The algorithm used: ((*Salmonella** AND (((Chicken* OR Poultr*) OR broiler*) OR gallus)) AND (slaughter* OR process*))
Study records: Data management	11 a	Describe the mechanism(s) that will be used to manage records and data throughout the review	From the search engines, the literature search results were exported to Mendeley for deduplication, and then shared with two other reviewers for title/abstracts screening. Pre-tested checklists were used along the screening process. Data extraction was done using MS Access, then exported to MS Excel. Data analysis was done using Metafor package (Version 3.8-1) in R-programme (version 4.2.0).
Selection process	11 b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	Two independent reviewers screened the titles and articles after deduplication using the checklist provided. The reviewers then screened the reports to confirm that the inclusion criteria had been adhered to. Disagreement was solved through discussions and/ or arbitration by a third reviewer. Since Mendeley was used, it was impossible to blind to journal titles, authors, or study institutions.
Data collection process	11 c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	Data extraction was done in duplicate, that is, the two reviewers extracted data independently from each eligible study using standardized MS Access forms. As with the selection process, disagreement will be solved through discussions and/ or arbitration by a third reviewer.
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	The extracted data comprised of; Article identification, Sampling point, Intervention details, Type of control used, Exposure details to intervention, Sampling, Microbial culture, Microbial confirmation, Trial size, and Publication status.
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including	The main intended outcome was the reduction or increase in concentration and prevalence of *Salmonella* spp. when a given

		prioritization of main and additional outcomes, with rationale	decontamination interventions had been tested during broiler primary processing. Concentration reduction was the difference between control and treatment groups, while relative risks was used in prevalence trials. In terms of data set for the outcomes, categorical data was obtained for prevalence trials while continuous data was collected for concentration trials.
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	The Cochrane Collaboration tool was adopted (with modifications) to assess risk of bias within studies. The specific areas assessed include study design adequacy and set-up, sampling, sequence generation, allocation concealment, blinding, selective outcome reporting and statistical appropriateness. For each, a brief description of the activity was recorded and evaluated based on possible risk of bias as 'high risk', 'unclear risk' or 'low risk'. Disagreements were cleared through discussions or the third reviewer acting as the arbitrator.
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised	The meta-analysis was run using a random-effects model for heterogenous data set while fixed effect model will be used for homogenous data set.
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I2, Kendall's τ)	Measures of treatment effect • For categorical outcomes (prevalence), effect was evaluated using risk ratio (RR) with 95% confidence interval (CI). • For continuous outcomes (concentration), raw mean differences was used to evaluate the odds ratio (OR) with 95% CI Dealing with missing data: there was no missing data from the included studies. The following scale was used to rate heterogeneity: I^2 statistic (0% to 40% assumed to be unimportant; 50% to 60% to represent moderate heterogeneity; and above 60%, heterogeneity will be considered substantial. Q-test will used to indicate heterogeneity, and τ^2 will indicate variability. Data synthesis

			Once extracted, data was run using R-packages. The Mantel-Haenszel method adopted for the fixed effect model, while DerSimonian and Laird) method used for the random effect model. The random effect model was used only where heterogeneity was significant (I^2 <50% or P <0.1)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	Subgroup analysis to explore likely causes of heterogeneity, based on the following: sampling point, intervention (physical vs chemical), technique (spray vs immersion vs cloaca treatment), publication year, and sample size Meta-regression was done using a mixed-effects model to evaluate which study characteristics account for heterogeneity and adjust for probable confounders across the studies
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	Descriptive characteristics was provided using systematic narrative synthesis with data presented using text and tables. The narrative synthesis was used to bring out the relationship and findings within-studies and between-studies. This was based on modification of Centre for Reviews and Dissemination guidelines
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	The fixed effect estimates were compared against the random effects model, and for each, forest and funnel plots developed to assess the possible presence of small sample effect on the bias. Mixed-effect meta-regression model used to explain bias across studies.
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	Evidence was evaluated based on the Grading of Recommendations Assessment, Development and Evaluation. On this, quality encompassed risk of bias, publication bias, reliability, directness, and accuracy. The strength was rated as (i) high, (ii) moderate, (iii) low or (iv) very low

***The PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

Adopted from (Moher *et al.*, 2015)

Section B: Search strategy used for a systematic review-meta-analysis investigating the change in prevalence and concentration of *Salmonella* spp. in broiler chickens during primary processing

Algorithm

((*Salmonell** AND (((Chicken* OR Poultry*) OR broiler*) OR gallus)) AND (slaughter* OR process*))

Timespan: 01/01/1998- 30/09/2022 (Date of completion of database search)

Databases and captured citations prior to de-dublication

1. Web of Science- 848 hits
2. PubMed- 1324
3. Dimensions- 384 hits
4. African Index Medicus- 13 hits
5. Web-searching-
    a. Databases searched: Google (8 hits), Google Scholar (1220 hits), and CAB Abstracts- 12 hits

Section C: Screening tool for abstracts for the systematic-review meta-analysis investigating the change in prevalence and concentration of *Salmonella* spp. in broiler chickens during primary processing.

RefID: _____
Reviewer: _____

Question 1 - Does this abstract pertain to primary research and results written in English?

1. From the title abstract, is it evident that the authors collected and analyzed their own data?

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point
   Take note of review articles
2. Can you retrieve an English version of this article?

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point

Note that primary research in the screening process refers to Scalding, Defeathering, Evisceration, Inside-Outside Carcass wash, Chilling or Post-chill storage
Broiler chickens exclude spent hens and other fowl for human consumption. At this point, assume 'poultry' or 'chicken' refers to broilers.

3. Does the study investigate the effects of a decontamination intervention on the prevalence or concentration outcome, on broiler chickens, during primary processing of broiler chickens?

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point
4. Are the results from samples collected at specific points during primary processing of broiler chickens?

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point
5. Does the study investigate the effects of a decontamination intervention on broiler chickens, and **NOT** the processing environment (surfaces, air, process water)?

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point
6. Does the sample refer to typical broiler breeds slaughtered at 5-7 weeks of age?

[ ] Yes
[ ] No
[ ] Can’t tell at this point

Section D: Relevance screening tool for full articles for the systematic-review investigating the change in prevalence and concentration of *Salmonella* spp. in broiler chickens from scalding to post-chill.

RefID: _____
Reviewer: _____

Relevance criteria

1. Have the authors used an appropriate study design in this study? Have the researcher adequately measured the outcome of interest before a treatment and after a treatment.

   [ ] Yes
   [ ] No
   [ ] Can't tell at this point

The samples can either be inoculated or naturally contaminated and the extent of an outcome may be from an earlier point during the primary processing. The designs to accept include Randomized control trials, challenge trials, Before-after-trials. Reject full articles if it's a cohort study, cross-sectional, surveillance reports, modelling and risk analysis publications based on secondary literature. Articles and trials were also accepted if sampling was done to evaluate the effects over a series of different sampling points. Trials refers to treatment-to-control comparisons made within a study. An effect is evaluated by changes in prevalence (frequency or presence/absence) or concentration (colony forming units (CFU) or most probable number (MPN) per unit measured) within a study.

2. Have the methods/ methodology/ procedures been adequately described and presented?

   [ ] Yes
   [ ] No

3. Have the results being adequately presented?

   [ ] Yes
   [ ] No

4. Can specific details of each trial together with its results (control and treatment) be properly extracted?

   [ ] Yes
   [ ] No
   [ ] Data can be adequately extracted from images using available R-packages

Section E: Risk of Bias Assessment Checklists used for the systematic review investigating the change in prevalence and concentration of *Salmonella* in broiler chickens from scalding to post-chill.

The checklist was based on GRADE (Grading of Recommendations Assessment, Development, and Evaluation) as recommended (Schünemann *et al.*, 2011).

Quality item	**Coding (Please circle the applicable one)**	**Description**
Study design adequacy	Yes	The design is clearly stated including sample size, intervention details, outcomes and controls that will be measured.
	No	One or more of the components are missing.
Sample size justification	Yes	Used formulas, based on desired power or precision and estimate of expected variability to detect differences.
	No	No details in the text, convenient or judgemental sampling done.
Allocation sequence adequately generated	Yes	Allocation sequence is described in enough detail
	No	Sample picked with no formal process for randomization, that is, sampling was judgmental, convenient, & purposive
Allocation concealment or blinding adequate	Yes	Concealment or blinding described
	Not described	No enough details on allocation concealment/ blinding
Adequate description of procedure	Yes	Clearly stated procedures (time, temperature, process environment, process capacity
	No	Description not clearly stated

Study set-up	Actual factory set up	Intervention implemented in a typical broiler processing facility and used commercial equipment
	Pilot plant set up	Intervention implemented in a pilot plant
	Lab design	Simulated processing done in the lab
Appropriateness of control group used	Yes	Yes
	No	No
Use of standard methods to culture & confirmation *Salmonella*	Yes	Standard methods were used and have been adequately described.
	No	Not clear
Report all intended outcomes with no evidence of exclusion of some samples from the results	Yes	The results address all intended outcomes
	No	Evidence some outcomes have been excluded from the results
Appropriateness of statistical analysis, including presentation of measures of variability	Yes	The results fit the study design, outcomes (parameter estimates & measures of variability) adequately presented.
	No	Statistical analysis and measures of variability not properly presented or carried out.
Presence of a dose-response gradient	Yes	The authors present a clear dose-response effect in the study
	No	Not presented
Presence of any other any concerns that may contribute to bias	Yes	Kindly state in brief
	No	None detected during screening or inclusion
	Low Risk of Bias	Minimal biases indicated, acceptable bias is unlikely across the study

Based on GRADE, how **would GRADE** the risk of bias in this study (GRADE 1-10, new)	Unclear Risk of Bias	Elements of acceptable bias detected in the study, that creates uncertainty in the results
	High Risk of Bias	Unacceptable bias identified across the study that consequently affects the overall results

Adopted from (Centre for Reviews and Dissemination, 2009)

Section F: Findings on Risk of Bias Assessment

Allocation concealment and blinding was not reported by any study, and none of the studies justified the sample size used. Allocation sequence was inadequately generated in most studies.

Table 1: Descriptive characteristics of the trials (studies) for inclusion in the systematic review

Article ID	Study design adequacy	Sample size justification	Allocation sequence adequately generated	Allocation concealment or blinding	Adequate description of procedures	Study set-up	Appropriateness of control group	Use of standard methods	Report all intended outcomes	Appropriateness of statistical analysis	Dose-response gradient	Any other concern	Overall RoB
A10	Yes	No	No	No	Yes	Lab	Yes	Yes	Yes	Yes	No	None	Low
A14	Yes	No	No	No	No	Lab	Yes	Yes	No	Yes	No	None	Unclear
A16	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	Different factories	Unclear
A18	Yes	No	Yes	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A2	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A20	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	Residual bacteriostatic activity not factored	Unclear
A21	Yes	No	No	No	No	Factory	Yes	Yes	No	Yes	No	None	Low
A23	Yes	No	Yes	No	Yes	Factory	Yes	Yes	Yes	No	No	None	Unclear
A24	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A25	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Artificial contamination	Unclear
A27	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	Yes	None	Low
A29	Yes	No	No	No	Yes	Pilot	Yes	Yes	No	Yes	No	Residual bacteriostatic	Unclear

												activity not factored	
A3	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	None	Low
A30	Yes	No	Yes	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A31	Yes	No	Yes	No	Yes	Pilot	Yes	Yes	No	Yes	No	None	Low
A32	Yes	No	Yes	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	None	Low
A33	Yes	No	Yes	No	Yes	Factory	No	Yes	Yes	Yes	No	Samples from 3 factories	Unclear
A36	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Patented intervention	Unclear
A38	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Patented intervention	Low
A40	Yes	No	Yes	No	Yes	Factory	Yes	Yes	Yes	Yes	Yes	None	Low
A42	Yes	No	No	No	Yes	Pilot	Yes	Yes	No	Yes	No	Groups of Salmonella serovars assessed	Unclear
A45	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Genetically featherless, artificial contamination	Unclear
A5	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A50	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	Cross-factory	Unclear
A52	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Artificial contamination	Low
A54	Yes	No	No	No	Yes	Lab	Yes	Yes	Yes	Yes	No	Artificial contamination	Unclear
A55	Yes	No	No	No	Yes	Lab	No	Yes	Yes	Yes	No	None	Low
A56	Yes	No	No	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Artificial contamination	Low
A57	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	None	Low
A58	Yes	No	No	No	No	Lab	Yes	Yes	Yes	Yes	No	Artificial contamination	Unclear
A59	Yes	No	No	No	No	Lab	Yes	Yes	Yes	Yes	No	Artificial contamination	Low

A6	Yes	No	No	No	No	Factory	Yes	Yes	Yes	Yes	Yes	None	Low
A60	Yes	No	No	No	No	Pilot	Yes	Yes	Yes	Yes	No	Artificial contamination	Unclear
A61	Yes	No	No	No	Yes	Factory	Yes	Yes	Yes	Yes	No	Different factories	Low
A62	Yes	No	No	No	Yes	Pilot	No	Yes	Yes	Yes	No	Artificial contamination	Unclear
A63	Yes	No	Yes	No	Yes	Pilot	Yes	Yes	Yes	Yes	No	Patented intervention	Unclear
A9	Yes	No	No	No	No	Factory	Yes	Yes	Yes	Yes	No	None	Low

Section G: Data extraction tool for a systematic-review meta-analysis investigating the change in prevalence and concentration of *Salmonella* spp. in broiler chickens during primary processing

Variable	Description	Entry
Article ID	Brief description of article	Author, year, country
Sampling point	Point where samples were collected	Sampling point
Intervention type	Decontamination intervention done	Intervention type
Intervention details	Detailed description of the decontamination intervention	Technique, inoculum, exposure time, exposed part
Microbial sampling	Samples collection	Type of analysed sample
Microbial analysis	Description of steps done for microbial analysis	Non-selective enrichment, selective enrichment, isolation media, purification media, confirmation
Counts/ prevalence	Findings of the trial	Initial concentration (log counts)/ prevalence, variability (Standard deviation/ standard error)

Section H: Extracted data for the systematic review meta-analysis on the effectiveness of processing interventions along broilers abattoirs on *Salmonella*

Article ID	Country	Sampling	Intervention type	Technique	Inoculum type	Exposure time (min)	Exposed part	Type of analysed sample	Conc/ prev	Effect	SD	N	RoB
A32	USA	Scalding & Defeathering	High temperature	immersion	Soft scald (50°C for 90 s) at pH of 11.0→Hard scald (56.6°C for 45 s) at pH of 11.0	45	WC	WCR	Conc	0.75	0.07	50	L
A32	USA	Scalding & Defeathering	High temperature	immersion	High pH (NaOH) Soft scald (50°C for 90 s) at pH of 11.0→High pH (NaOH) Hard scald (56.6°C for 45 s) at pH of 11.0	45	WC	WCR	Conc	0.3	0.06	50	L
A45	USA	Scalding & Defeathering	Forced Cloacal Fecal Expulsion	cloaca treatment	Washing→ squeeze only	<1	WC	WCR	Conc	-4.9	0.30	9	U
A45	USA	Scalding & Defeathering	Forced Cloacal Fecal Expulsion	cloaca treatment	Washing→ Squeeze + Wash	<1	WC	WCR	Conc	-3.5	0.30	9	U
A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 95 C from 3 to 5 secs	<1	WC	CCS	Conc	0.73	0.45	7	U
A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 95 C from 3 to 5 secs	<1	WC	CCS	Conc	0.71	0.33	7	U

A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 95 C from 3 to 5 secs	<1	WC	CCS	Conc	0.54	0.18	7	U
A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 120 C from 3 to 5 secs	<1	WC	CCS	Conc	0.94	0.50	7	U
A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 120 C from 3 to 5 secs	<1	WC	CCS	Conc	0.43	0.26	7	U
A62	Norway	Evisceration	Steam pasteurization	Steam	Steam at 120 C from 3 to 5 secs	<1	WC	CCS	Conc	0.42	0.16	7	U
A25	USA	Inside-Outside Carcass wash	Electrolyzed water	spray	EO (electrolyzed oxidising water) pH 2.4, oxidation reduction potential of 1,180 mV containing 50 mg/L of total chlorine	10	WC	WCR	Conc	2.7	0.55	10	U
A25	USA	Inside-Outside Carcass wash	Sodium hypochlorite	spray	50 mg/L of HOCl solution (pH 8.0)	10	WC	WCR	Conc	2.4	0.58	10	U
A54	USA	Inside-Outside Carcass wash	Chlorine	spray	0 ppm→50 ppm Chlorine, water temperature 21.1°C	5	WC	WCR	Conc	0.1	0.62	4	U
A54	USA	Inside-Outside Carcass wash	Chlorine	spray	0 ppm→50 ppm Chlorine, water temperature 43.3°C	5	WC	WCR	Conc	0.3	0.62	4	U
A54	USA	Inside-Outside Carcass wash	Chlorine	spray	0 ppm→50 ppm Chlorine, water temperature 54.4°C	5	WC	WCR	Conc	0	0.63	4	U
A56	USA	Inside-Outside	Trisodium phosphate	spray	control- water spray→10% TSP, pH	17	WC	WCR	Conc	1.36	0.18	10	L

		Carcass wash			12.3, spray for 17 secs, temperature 35C, spraying pressure at 413 kPa, setting time 60 secs, then rinsed with water at a pressure of 551 kPa for 17 s to remove chemical residue								
A56	USA	Inside-Outside Carcass wash	Lactic acid	spray	control- water spray→2% lactic acid, spray for 17 secs, temperature 35C, spraying pressure at 413 kPa, setting time 60 secs, then rinsed with water at a pressure of 551 kPa for 17 s to remove chemical residue	17	WC	WCR	Conc	1.21	0.15	10	L
A56	USA	Inside-Outside Carcass wash	Cetylpyridinium chloride	spray	control- water spray→0.5% cetylpyridinium chloride (CPC) spray for 17 secs, temperature 35C, spraying pressure at 413 kPa, setting time 60 secs, then rinsed with water at a pressure of 551 kPa for 17 s to remove chemical residue	17	WC	WCR	Conc	1.62	0.20	10	L
A56	USA	Inside-Outside Carcass wash	Sodium bisulfate	spray	control- water spray→5% sodium bisulfate (SBS) spray for 17 secs, temperature 35C, spraying pressure at 413 kPa, setting time 60 secs, then rinsed with water at a	17	WC	WCR	Conc	1.47	0.18	10	L

					pressure of 551 kPa for 17 s to remove chemical residue								
A24	Ireland	Post-IOCW & Pre-Chill	Trisodium phosphate	immersion	Portable water→10% (wt/vol) TSP	15	WC	CCS	Conc	0.56	0.08	5	L
A10	USA	Chilling	Immersion→air chilling	immersion → air chilling	ice and potable water mixture (approximately 0.6 C), 2 rpm, 50-min → continuous flow of air with velocity 3.5 m/s, air less than 0 C, for 150 mins	9000	WC	WCR	Conc	0.4	0.35	18	L
A23	USA	Chilling	Immersion→air chilling	immersion → air chilling	air velocity 3.6 m/min, temperature of 0°C and RH of 72%, chilling time 120 min →0.5 to 1.1°C water with 5 mg/kg of free chlorine with birds exposed to air agitation during the first 25 min. total immersion time 80 min	<1	WC	WCR	Conc	0.57	0.02	10	U
A23	USA	Chilling	Immersion- air combi	air → immersion-air combi	air velocity 3.6 m/min, temperature of 0°C and RH of 72%, chilling time 120 min →0.5 to 1.1°C water with 5 mg/kg of free chlorine with birds exposed to air agitation during the first 25 min. total immersion time 80 min → Step 1: 4 tanks with temp at 8, 5, 5, and 2°C, respectively. Time 20	<1	WC	WCR	Conc	0	0.00	10	U

					s (1st tank), 40 s (2nd tank), 80 s (3rd tank), and 80 s (4th tank). Drain time between tanks 30, 60, and 60 s. Step 2: air chill-velocity 3.6 m/min, 0°C and RH of 72%, for 120 mins								
A23	USA	Chilling	Immersion- air combi	immersion → Immersion-air combi	0.5 to 1.1°C water with 5 mg/kg of free chlorine with birds exposed to air agitation during the first 25 min. total immersion time 80 min → Step 1: 4 tanks with temp at 8, 5, 5, and 2°C, respectively. Time 20 s (1st tank), 40 s (2nd tank), 80 s (3rd tank), and 80 s (4th tank). Drain time between tanks 30, 60, and 60 s. Step 2: air chill-velocity 3.6 m/min, 0°C and RH of 72%, for 120 mins	<1	WC	WCR	Conc	0.57	0.02	10	U
A36	USA	Chilling	Chlorine	immersion	chlorine treatment (pH 7.34, 51.9 ppm of free chlorine) - Inoculated drummette	2700	CC	CCR	Conc	0.38	0.12	20	U
A36	USA	Chilling	Chlorine	immersion	chlorine stabilizer (T-128) based on phosphoric acid–propylene glycol (pH 2.99, 0.00 ppm of free chlorine) - Inoculated drummette	2700	CC	CCR	Conc	0.27	0.12	20	U
A36	USA	Chilling	Chlorine	immersion	chlorine with chlorine stabilizer (T-128) based on	2700	CC	CCR	Conc	0.7	0.12	20	U

					phosphoric acid–propylene glycol (pH 3.59, 50.5 ppm of free chlorine) - Inoculated drummette								
A36	USA	Chilling	Chlorine	immersion	Chlorine treated with 0.01% H3PO4 (pH 3.42, 50.5 ppm of free chlorine)→ chlorine treated with phosphoric acid–propylene glycol chlorine stabilizer (pH 3.55, 50.6 ppm of free chlorine) - Inoculated drummette	2700	CC	CCR	Conc	0.15	0.05	20	U
A36	USA	Chilling	Chlorine	immersion	chlorine treatment (pH 7.34, 51.9 ppm of free chlorine) - uninoculated drummette	2700	CC	CCR	Conc	0.57	0.13	20	U
A36	USA	Chilling	Chlorine	immersion	chlorine stabilizer (T-128) based on phosphoric acid–propylene glycol (pH 2.99, 0.00 ppm of free chlorine) - uninoculated drummette	2700	CC	CCR	Conc	0.25	0.13	20	U
A36	USA	Chilling	Chlorine	immersion	chlorine with chlorine stabilizer (T-128) based on phosphoric acid–propylene glycol (pH 3.59, 50.5 ppm of free chlorine) - uninoculated drummette	2700	CC	CCR	Conc	1.15	0.13	20	U
A36	USA	Chilling	Chlorine	immersion	Chlorine treated with 0.01% H3PO4 (pH 3.42, 50.5 ppm of free chlorine)→ chlorine treated with phosphoric acid–propylene glycol	2700	CC	CCR	Conc	0.56	0.08	20	U

					chlorine stabilizer (pH 3.55, 50.6 ppm of free chlorine) - Uninoculated drummette								
A42	USA	Chilling	Sodium hypochlorite	immersion	control- tap water→sodium hypochlorite (50 ppm)	3600	WC	WCR	Conc	-0.01	0.07	30	U
A42	USA	Chilling	Monochloramine	immersion	control- tap water→monochloramine (50 ppm)	3600	WC	WCR	Conc	0.02	0.07	30	U
A49	USA	Chilling	Peracetic acid	immersion	0.003% chlorine→0.0025% peracetic acid	<1	WC	WCR	Conc	0.8	0.69	100	L
A49	USA	Chilling	Peracetic acid	immersion	0.003% chlorine→0.01% peracetic acid	<1	WC	WCR	Conc	1.1	0.69	100	L
A49	USA	Chilling	Peracetic acid	immersion	0.003% chlorine→0.02% peracetic acid	<1	WC	WCR	Conc	1.2	0.69	100	L
A52	USA	Chilling	Portable water	immersion	No treatment→ distilled water, chilled to 4C	<1	WC	WCR	Conc	-0.5	0.52	4	L
A52	USA	Chilling	Electrolyzed water	immersion	control- distilled water→EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL), chilled to 4C	<1	WC	WCR	Conc	1.33	0.43	4	L
A52	USA	Chilling	Acetic acid	immersion	control- distilled water→2% acetic acid, chilled to 4C	<1	WC	WCR	Conc	1.91	0.41	4	L
A52	USA	Chilling	Trisodium phosphate	immersion	control- distilled water→10% TSP, chilled to 4C	<1	WC	WCR	Conc	1.91	0.41	4	L
A52	USA	Chilling	Sodium hypochlorite	immersion	control- distilled water→20 ppm sodium hypochlorite, chilled to 4C (chlorine)	<1	WC	WCR	Conc	0.45	0.43	4	L

A52	USA	Chilling	Ozonated water	immersion	control- distilled water→10 mg/L ozonated water (OZ), chilled to 4 C (ozone)	<1	WC	WCR	Conc	1.24	0.45	4	L
A52	USA	Chilling	Portable water	spray	No treatment→ distilled water, chilled to 4C	15	HC	HCR	Conc	0.87	0.14	4	L
A52	USA	Chilling	Electrolyzed water	spray	control- distilled water→EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL), chilled to 4C	15	HC	HCR	Conc	-0.28	0.16	4	L
A52	USA	Chilling	Acetic acid	spray	control- distilled water→2% Acetic Acid sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer	15	HC	HCR	Conc	-0.04	0.13	4	L
A52	USA	Chilling	Trisodium phosphate	spray	control- distilled water→10% TSP sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer	15	HC	HCR	Conc	0.03	0.14	4	L
A52	USA	Chilling	Sodium hypochlorite	spray	control- distilled water→20 ppm sodium hypochlorite, sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer	15	HC	HCR	Conc	-0.04	0.18	4	L
A52	USA	Chilling	Ozonated water	spray	control- distilled water→10 mg/L ozonated water OZ] sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer	15	HC	HCR	Conc	-0.28	0.16	4	L
A52	USA	Chilling	Electrolyzed water	spray →	basic electrolyzed oxidizing water spray	<1	WC	WCR	Conc	2.11	0.39	4	L

			(basic + acidic)	immersion	treatment (25 mL basic EO water (pH 11.6, −795 mV ORP), followed by immersion in acidic EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL)								
A52	USA	Chilling	Acetic acid + sodium hypochlorite	spray → immersion	25 mL of 2% Acetic acid spray, followed by immersion in 50 ppm sodium hypochlorite	<1	WC	WCR	Conc	2	0.54	4	L
A52	USA	Chilling	Trisodium phosphate + sodium hypochlorite	spray → immersion	25 mL of 10% TSP spray, followed by immersion in 50 ppm sodium hypochlorite	<1	WC	WCR	Conc	1.95	0.44	4	L
A60	USA	Chilling	Visible fecal or ingesta	immersion	no fecal → fecal contamination during immersion chilling	2700	HC	HCR	Conc	0.1	0.10	24	U
A63	USA	Chilling	Peracetic Acid	immersion	Post-evscreation dip at 400 ppm followed by immersion in stationary chill tank at 25 ppm	60	WC	WCR	Conc	0.785	0.13	10	U
A63	USA	Chilling	Peracetic Acid	immersion	Post-evscreation dip at 400 ppm followed by immersion in stationary chill tank at 45 ppm	60	WC	WCR	Conc	0.518	0.17	10	U
A63	USA	Chilling	Peracetic Acid	immersion	Post-evscreation dip at 600 ppm followed by immersion in stationary chill tank at 25 ppm	60	WC	WCR	Conc	0.492	0.18	10	U
A63	USA	Chilling	Peracetic Acid	immersion	Post-evscreation dip at 600 ppm followed by	60	WC	WCR	Conc	0.782	0.13	10	U

					immersion in stationary chill tank at 45 ppm								
A27	USA	Post-Chill	Portable water	immersion	Portable water	20	WC	WCR	Conc	0.6	0.41	10	L
A27	USA	Post-Chill	Chlorine	immersion	Portable water → 0.004% (40 ppm) Chlorine	20	WC	WCR	Conc	0.2	0.42	10	L
A27	USA	Post-Chill	Peracetic acid	immersion	Portable water →0.04% (400 ppm) peracetic acid (PAA)	20	WC	WCR	Conc	1.4	0.41	10	L
A27	USA	Post-Chill	Peracetic acid	immersion	Portable water →0.1% (1000 ppm) peracetic acid (PAA)	20	WC	WCR	Conc	1.5	0.40	10	L
A27	USA	Post-Chill	Lysozyme	immersion	Portable water →0.1% (1000 ppm) lysozyme	20	WC	WCR	Conc	0.2	0.40	10	L
A27	USA	Post-Chill	Lysozyme	immersion	Portable water →0.5% (5000 ppm) lysozyme	20	WC	WCR	Conc	0.3	0.39	10	L
A52	USA	Post-Chill	Portable water	immersion	No treatment→ distilled water, chilled to 4C	<1	WC	WCR	Conc	0.35	0.63	4	L
A52	USA	Post-Chill	Electrolyzed water	immersion	control- distilled water→EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL), chilled to 4C- (7 days post-chill after immersion chill with chemical antimicrobials)	<1	WC	WCR	Conc	0.63	0.56	4	L
A52	USA	Post-Chill	Acetic acid	immersion	control- distilled water→2% acetic acid to 4C- 7 days post-chill after immersion chill with chemical antimicrobials	<1	WC	WCR	Conc	0.63	0.56	4	L
A52	USA	Post-Chill	Trisodium phosphate	immersion	control- distilled water→10% TSP 7 days post-chill after immersion chill with chemical antimicrobials	<1	WC	WCR	Conc	0.63	0.56	4	L

A52	USA	Post-Chill	Sodium hypochlorite	immersion	control- distilled water→20 ppm sodium hypochlorite- (chlorine) 7 days post-chill after immersion chill with chemical antimicrobials	<1	WC	WCR	Conc	-0.07	0.65	4	L
A52	USA	Post-Chill	Ozonated water	immersion	control- distilled water→10 mg/L ozonated water (OZ) ozone 7 days post-chill after immersion chill with chemical antimicrobials	<1	WC	WCR	Conc	0.63	0.56	4	L
A52	USA	Post-Chill	Portable water	spray	No treatment→ distilled water, chilled to 4C	15	HC	HCR	Conc	1.65	0.21	4	L
A52	USA	Post-Chill	Electrolyzed water	spray	control- distilled water→EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL) sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer 7 days post-chill after spray chill with chemical antimicrobials	15	WC	HCR	Conc	-0.59	0.20	4	L
A52	USA	Post-Chill	Acetic acid	spray	control- distilled water→2% Acetic acid sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer- 7 days post-chill after spray chill with chemical antimicrobials	15	WC	HCR	Conc	0.66	0.18	4	L
A52	USA	Post-Chill	Trisodium phosphate	spray	control- distilled water→10% TSP sprayed 15 s at 85 psi (100 oscillations per min) using	15	WC	HCR	Conc	0.52	0.21	4	L

					a carcass washer- 7 days post-chill after spray chill with chemical antimicrobials								
A52	USA	Post-Chill	Sodium hypochlorite	spray	control- distilled water→20 ppm sodium hypochlorite, sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer- 7 days post-chill after spray chill with chemical antimicrobials	15	WC	HCR	Conc	-0.29	0.19	4	L
A52	USA	Post-Chill	Ozonated water	spray	control- distilled water→10 mg/L ozonated water OZ] sprayed 15 s at 85 psi (100 oscillations per min) using a carcass washer- 7 days post-chill after spray chill with chemical antimicrobials	15	WC	HCR	Conc	-0.05	0.20	4	L
A52	USA	Post-Chill	Electrolyzed water (basic + acidic)	spray → immersion	basic electrolyzed oxidizing water spray treatment (25 mL basic EO water (pH 11.6, −795 mV ORP), followed by immersion in acidic EO water (pH 2.4 to 2.7, 1,150 mV ORP, 50 ppm free CL)	<1	WC	WCR	Conc	3.81	0.42	4	L
A52	USA	Post-Chill	Acetic acid + sodium hypochlorite	spray → immersion	25 mL of 2% Acetic acid spray, followed by immersion in 50 ppm sodium hypochlorite	<1	WC	WCR	Conc	3.13	0.45	4	L

A52	USA	Post-Chill	Trisodium phosphate + sodium hypochlorite	spray → immersion	25 mL of 10% TSP spray, followed by immersion in 50 ppm sodium hypochlorite	<1	WC	WCR	Conc	2.67	0.39	4	L
A58	USA	Post-Chill	Binary Ionization Technology (BIT) spray	spray	BIT spray (30 mL/min, 15,000 V) for 60 s. Control carcasses were sprayed with sterile water for 60 s, also at 30 mL/min.	60	WC	CCS	Conc	1.17	0.49	10	U
A58	USA	Post-Chill	Binary Ionization Technology (BIT) spray	spray	BIT spray (30 mL/min, 15,000 V) , 4 intervals of 15 s with 5 to 10 s between each interval. Control carcasses were sprayed with sterile water for 60 s, also at 30 mL/min.	60	WC	CCS	Conc	1.93	0.38	10	U
A58	USA	Post-Chill	Binary Ionization Technology (BIT) spray	spray	BIT spray (30 mL/min, 15,000 V) , 3 intervals of 12 s and sprayed with air for 12 to15 s between each interval. Control carcasses were sprayed with sterile water for 60 s, also at 30 mL/min.	60	WC	CCS	Conc	3.25	0.66	10	U
A59	Turkey	Post-Chill	Portable water	immersion	Control- sterile tap water	15	BS	CCS	Conc	0.1	0.09	3	L
A59	Turkey	Post-Chill	Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC-Acidified using citric acid	15	BS	CCS	Conc	1.3	0.07	3	L
A59	Turkey	Post-Chill	Trisodium phosphate	immersion	Control- sterile tap water→10.0% TSP	15	BS	CCS	Conc	1.4	0.07	3	L

A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC followed by 10.0% TSP	15	BS	CCS	Conc	1.5	0.07	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→10.0% TSP followed by 0.1% ASC	15	BS	CCS	Conc	1.5	0.07	3	L
A59	Turkey	Post-Chill	Portable water	immersion	Control- sterile tap water + 1 day post-chill storage	15	BS	CCS	Conc	0.2	0.15	3	L
A59	Turkey	Post-Chill	Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC-Acidified using citric acid + 1 day post-chill storage	15	BS	CCS	Conc	1.4	0.11	3	L
A59	Turkey	Post-Chill	Trisodium phosphate	immersion	Control- sterile tap water→10.0% TSP + 1 day post-chill storage	15	BS	CCS	Conc	1.9	0.12	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC followed by 10.0% TSP + 1 day post-chill storage	15	BS	CCS	Conc	1.6	0.11	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→10.0% TSP followed by 0.1% ASC + 1 day post-chill storage	15	BS	CCS	Conc	1.5	0.11	3	L
A59	Turkey	Post-Chill	Portable water	immersion	Control- sterile tap water + 3 day post-chill storage	15	BS	CCS	Conc	0.3	0.10	3	L

A59	Turkey	Post-Chill	Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC-Acidified using citric acid + 3 day post-chill storage	15	BS	CCS	Conc	1.6	0.10	3	L
A59	Turkey	Post-Chill	Trisodium phosphate	immersion	Control- sterile tap water→10.0% TSP + 3 day post-chill storage	15	BS	CCS	Conc	2.4	0.09	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC followed by 10.0% TSP + 3 day post-chill storage	15	BS	CCS	Conc	1.7	0.09	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→10.0% TSP followed by 0.1% ASC + 3 day post-chill storage	15	BS	CCS	Conc	1.9	0.09	3	L
A59	Turkey	Post-Chill	Portable water	immersion	Control- sterile tap water + 5 day post-chill storage	15	BS	CCS	Conc	0.3	0.12	3	L
A59	Turkey	Post-Chill	Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC-Acidified using citric acid + 5 day post-chill storage	15	BS	CCS	Conc	1.5	0.12	3	L
A59	Turkey	Post-Chill	Trisodium phosphate	immersion	Control- sterile tap water→10.0% TSP + 5 day post-chill storage	15	BS	CCS	Conc	2.6	0.13	3	L
A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→0.1% ASC followed by 10.0% TSP + 5 day post-chill storage	15	BS	CCS	Conc	1.7	0.13	3	L

A59	Turkey	Post-Chill	Trisodium phosphate + Acidified sodium chlorite	immersion	Control- sterile tap water→10.0% TSP followed by 0.1% ASC + 5 day post-chill storage	15	BS	CCS	Conc	1.6	0.13	3	L
A9	Australia	Post-Chill	Acidified sodium chlorite	immersion	Control- No treatment → 900 mg/kg sodium chlorite, pH 2.5–2.6, acidified using citric acid	20	WC	WCR	Conc	0.05	0.14	30	L
A21	USA	Scalding	Additional washers	brush	prescald brush washer (conventional)	<1	WC	WCR	Prev	-4	0.00	5	L
A31	USA	Scalding	High temperature	immersion	24 C during the first 40-s scalding tank in a three-tank scalding system. Control temperature in first tank is 57 C.	40	WC	WCR	Prev	0	0.00	24	L
A32	USA	Scalding	High temperature	immersion	Soft scald (50°C for 90 s) at pH of 11.0→Hard scald (56.6°C for 45 s) at pH of 11.0	45	WC	WCR	Prev	20	0.00	50	L
A32	USA	Scalding	High pH + High Temperature	immersion	High pH (NaOH) Soft scald (50°C for 90 s) at pH of 11.0→High pH (NaOH) Hard scald (56.6°C for 45 s) at pH of 11.1	45	WC	WCR	Prev	13	0.00	50	L
A38	USA	Scalding	Acidic copper sulfate	immersion	pH 2.0, with 2.0 mg/L of copper sulfate in 2 mins countercurrent flow scalder	120	WC	WCR	Prev	30	0.00	10	L
A38	USA	Scalding	Acidic copper sulfate	immersion	pH 2.0, with 2.0 mg/L of copper sulfate in 2 mins countercurrent flow scalder, then also 10-12	132	WC	WCR	Prev	5	0.00	10	L

					sec post-pluck dip application								
A5	USA	Scalding	High pH	immersion	↑pH using lime slurry (calcium hydroxide): Control pH(6.88) →high pH (9.89)	207	WC	WCR	Prev	17.8	0.00	30	L
A61	Canada	Scalding	High Temperature	Immersion	From 225 birds/mins speed, 3 scald tanks, temperature 53.33-57.22, scalding time 90 secs, pluck for 35 mins to 230 birds/min speed, 2 scald tanks, temperature 50-61.7, scald time 80 secs, pluck for 26 mins	<1	WC	WCR	Prev	6.1	0.00	40	L
A2	USA	Scalding	Chlorine dioxide	spray	portable water→50 ppm of ClO2	<1	WC	WCR	Prev	33.3333333	0.00	10	L
A21	USA	Scalding	Additional washers	spray	post-defeathering spray washer	<1	WC	WCR	Prev	8	0.00	5	L
A33	USA	Scalding	Additional washers	spray	20 - 50 ppm chlorine	<1	WC	WCR	Prev	8	0.00	75	U
A5	USA	Scalding	Chlorine + high pH	immersion	High chlorine dip (83.3 mg/kg) after normal pH scalding (mean pH 6.04) →High chlorine dip (83.3 mg/kg) after high pH scald (mean pH 9.89)	5	WC	WCR	Prev	-51.25	0.00	30	L
A30	USA	Evisceration	Portable water	immersion	Tap water dipping (TWD) (25 C, 45 s) followedby second TWD (25 C, 45 s)	90	WC	CCS	Prev	0	0.00	15	L
A30	USA	Evisceration	Trisodium phosphate	immersion	Tap water dipping (TWD) (25 C, 45 s) followedby second TWD (25 C, 45 s) →Tap Water Dip (45 secs) followed by 8%	90	WC	CCS	Prev	40	0.00	15	L

					(wt/vol) trisodium phosphate dipping at 25 C (45 secs) -(TWD/TSP)								
A30	USA	Evisceration	High temperature	immersion	Tap water dipping (TWD) (25 C, 45 s) followedby second TWD (25 C, 45 s) →TWD (45 secs) followed by hot water dipping at 71 C (45 secs) (TWD/HWD)	90	WC	CCS	Prev	20	0.00	15	L
A30	USA	Evisceration	Trisodium phosphate + High temperature Dip	immersion	Tap water dipping (TWD) (25 C, 45 s) followedby second TWD (25 C, 45 s) →8% trisodium phosphate dipping at 25 C (45 secs) followed by hot water dipping at 71 C (45 secs) (TSP/HWD)	90	WC	CCS	Prev	53.3	0.00	15	L
A30	USA	Evisceration	Brushing	brush + immersion	Brushing when Tap Water Dip (25 C, 45 s) followed by TWD (25 C, 45 s) with intermittent manual brushing (5 s on/5 s off).	90	WC	CCS	Prev	27	0.00	30	L
A30	USA	Evisceration	Brushing +Hot water dip	brush + immersion	Brushing when TSP dipping (25 C, 45 s) followed by HWD (71 C, 45 s) with intermittent manual brushing (5 s on/5 s off)	90	WC	CCS	Prev	3	0.00	30	L
A33	USA	Evisceration	Additional washers	spray	20 - 50 ppm chlorine	<1	WC	WCR	Prev	9	0.00	75	U
A16	Brazil	IOCW	High pressure	spray	Trimming using a knife→High pressure spray (HPS)	5	WC	WCR	Prev	0.1242236	0.00	805	U

A16	Brazil	IOCW	High pressure	spray	High pressure spray (HPS), Carcass with NO visible gastrointestinal	5	WC	WCR	Prev	-1.656051	0.00	785	U
A16	Brazil	IOCW	High pressure	spray	High pressure spray (HPS), Carcass WITH visible gastrointestinal	5	WC	WCR	Prev	-0.7643312	0.00	785	U
A21	USA	IOCW	Additional washers	spray	pre IOBW spray washer	<1	WC	WCR	Prev	12	0.00	5	L
A21	USA	IOCW	Additional washers	brush	post IOBW brush washer	<1	WC	WCR	Prev	-4	0.00	5	L
A33	USA	IOCW	Additional washers	spray	20 - 50 ppm chlorine (IOBW 1)	<1	WC	WCR	Prev	5	0.00	75	U
A33	USA	IOCW	Additional washers	spray	20 - 50 ppm chlorine (IOBW 2)	<1	WC	WCR	Prev	4	0.00	75	U
A40	USA	Prechill	Acidified sodium chlorite	process realignment	offline reprocessing of visibly contaminated carcasses with visble fecal and ingesta→Continous online processing of visibly contaminated carcasses with visble fecal and ingesta using: spray 1,100 ppm sodium chlorite and 9,000 ppm citric acid. pH 2.5 +/- 0.05, temperature 14 to 18C, time 15 sec, volume sprayed per carcass 147 to 237ml	<1	WC	WCR	Prev	21.6	0.00	1070	L
A55	USA	Prechill	NaOH	immersion	High pH 8.5 (using NaOH) to mimic TSP pH	5	WC	EWC	Prev	-16	0.00	50	L
A55	USA	Prechill	Trisodium phosphate	immersion	High pH 8.5 (using NaOH)→TSP treatment pH 8.5	5	WC	EWC	Prev	14	0.00	50	L

A55	USA	Prechill	TSP + HCl	immersion	TSP treatment -pH 8.5→Neutral (pH 7.0) adjusted TSP dip using HCl	5	WC	EWC	Prev	-4	0.00	50	L
A20	USA	Prechill	Cetylpyridinium chloride	spray	cetylpyridinium chloride	<1	WC	WCR	Prev	11.29	0.00	15	U
A21	USA	Prechill	Additional washers	spray	Pre-chill spray washer	<1	WC	WCR	Prev	8	0.00	5	L
A29	USA	Prechill	Chlorine	immersion	Control- 500ml water drench→500-mL solution containing 500 mg/kg of chlorine (Residual chlorine = 4.33 mg/kg)	60	WC	WCR	Prev	0	0.00	26	U
A29	USA	Prechill	Chlorine	immersion	Control- 500ml water drench→500-mL solution containing 500 mg/kg of chlorine (pH adjusted to 7 so as to increase Residual chlorine = 8.18 mg/kg)	60	WC	WCR	Prev	-4	0.00	21	U
A33	USA	Prechill	Chlorine dioxide	spray	acidified 500 to 1,200 ppm sodium chlorite using citric acid to pH 2.5 to 2.9	<1	WC	WCR	Prev	8	0.00	75	U
A33	USA	Prechill	Trisodium phosphate	spray	8 to 12% TSP	<1	WC	WCR	Prev	7	0.00	75	U
A18	USA	Chilling	Immersion→air chilling	immersion → air chilling	120 min in an air-chilling room in two stages, with temperatures of -7.7 to -5.5°C and -4.4 to -1.1°C, respectively.→three-stage countercurrent immersion chiller for a total time of 85 min. 1st stage water at 17.2°C, second stage water at 5.6 to 6.7°C, and	5100	WC	WCR	Prev	6	0.00	150	L

					third stage water at -1.1 to 0°C. Chlorine in chiller approximately 40 ppm.								
A20	USA	Chilling	Immersion→air chilling	immersion → air chilling	150 mins at 1.0 m/s cold (1.0 +/- 0.2 C) after disinfection with cetylpyridinium chloride→50 mins; Total chlorine concentration in the chilling water (50- 90 ppm), free chlorine (0.4-0.8 ppm), water temperature 0.5 +/- 0.4 C	3000	WC	WCR	Prev	-12.91	0.00	15	U
A23	USA	Chilling	Immersion→air chilling	immersion → air chilling	0.5 to 1.1°C water with 5 mg/kg of free chlorine with birds exposed to air agitation during the first 25 min. total immersion time 80 min	4800	WC	WCR	Prev	-31	0.00	10	U
A23	USA	Chilling	Air-immersion/air combi	air → immersion-air combi	air velocity 3.6 m/min, temperature of 0°C and RH of 72%, chilling time 120 min	7200	WC	WCR	Prev	-7	0.00	10	U
A23	USA	Chilling	Immersion-Imersion/ air combi	immersion → Immersion-air combi	Step 1: 4 tanks with temp at 8, 5, 5, and 2°C, respectively. Time 20 s (1st tank), 40 s (2nd tank), 80 s (3rd tank), and 80 s (4th tank). Drain time between tanks 30, 60, and 60 s. Step 2: air chill-velocity 3.6 m/min, 0°C and RH of 72%, for 120 mins	7570	WC	WCR	Prev	-38	0.00	10	U

A33	USA	Chilling	Chlorine	immersion	20 to 50 ppm chlorinated water, pH 6.5 to 7.0	<1	WC	WCR	Prev	-2	0.00	75	U
A33	USA	Chilling	Chlorine dioxide	immersion	combination of ClO2 (prepared by acidifying 50 to 150 ppm sodium chlorite with citric acid to pH 2.8 to 3.2) and 20 to 50 ppm chlorinated water (chiller was operated at pH 6.5 to 7.0)	<1	WC	WCR	Prev	-10	0.00	75	U
A33	USA	Chilling	Chlorine	spray	At chiller exit- 20 to 50 ppm chlorinated water	<1	WC	WCR	Prev	0	0.00	75	U
A50	USA	Chilling	Visible fecal or ingesta	immersion	chilled without visible ingesta→chilled with visible ingesta	<1	WC	WCR	Prev	0.36	0.00	270	U
A57	USA	Chilling	Peracetic acid + hydrogen peroxide	immersion	30 ppm chlorine→85 ppm of PAHP (peracetic acid and hydrogen peroxide)	<1	WC	WCR	Prev	34.93	0.00	100	L
A60	USA	Chilling	Visible fecal or ingesta	immersion	no fecal → fecal contamination during immersion chilling	2700	HC	HCR	Prev	-18.33	0.00	24	U
A61	Canada	Chilling	Immersion→air chilling	immersion → air chilling	From dry air chilling at -3 to 2 C, for 90 mins, with Cetylpyridinium chloride, and water layover of 35L/min to a crossflow immersion chilling, tem 1-3 C for 90 minswith no chemical decontaminant	90	WC	WCR	Prev	-42.5	0.00	40	L
A61	Canada	Chilling	Immersion→air chilling	immersion → air chilling	From dry air chilling at 0,6 C, for 107 mins, with Cetylpyridinium chloride, and water layover of 110 L/min to a counterflow	110	WC	WCR	Prev	-5.1	0.00	40	L

					immersion chilling, tem 1 C for 110 mins with Peracetic acid								
A14	UK	Postchilling	Dry ice	spray	Dry ice blast (liquid CO2) for 15 secs	15	WC	CCS	Prev	66.6	0.00	18	U
A14	UK	Postchilling	Dry ice	immersion	Dry ice immersion (liquid CO2) for 15 secs	15	WC	CCS	Prev	44.4	0.00	18	U
A33	USA	Postchilling	Chlorine	spray	post-chill wash- 20 to 50 ppm chlorinated	<1	CC	CCR	Prev	6	0.00	75	U
A33	USA	Postchilling	Chlorine	spray	dropped carcass wash- 20 to 50 ppm chlorinated water	<1	WC	WCR	Prev	8	0.00	75	U
A33	USA	Postchilling	Chlorine	spray	dropped product wash- 20 to 50 ppm chlorinated water	<1	CC	CCR	Prev	3	0.00	75	U
A33	USA	Postchilling	Acidified sodium chlorite	immersion	Product dip- acidified 500 to 1,200 ppm sodium chlorite with citric acid to pH 2.5 to 2.9	<1	CC	CCR	Prev	28	0.00	75	U
A58	USA	Postchilling	Binary Ionization Technology (BIT) spray	spray	BIT- administered at 10,000 V sprayed for 4 secs. Control sprayed with sterile water for 5 sec	4	WC	WCR	Prev	5	0.00	20	U
A58	USA	Postchilling	Binary Ionization Technology (BIT) spray	spray	BIT- administered at 10,000 V sprayed for 8 secs. Control sprayed with sterile water for 5 sec	8	WC	WCR	Prev	15	0.00	20	U
A58	USA	Postchilling	Binary Ionization Technology (BIT) spray	spray	BIT- administered at 10,000 V. sprayed 3 times for 4 s with 4 s between pulses. Control sprayed with sterile water for 5 sec	12	WC	WCR	Prev	15	0.00	20	U

A9	Austr alia	Postchill ing	Acidified sodium chlorite	immer sion	Control- No treatment → 900 mg/kg sodium chlorite, pH 2.5–2.6, acidified using citric acid	20	WC	WCR	Prev	80	0.00	30	L

Exposed part:

- WC- Whole Carcass
- CC- Carcass cuts
- HC- Half carcass
- BS- Breast skin

Type of analyzed sample

- WCR- Whole carcass rinse
- CCR- Carcass cuts rinse
- CCS- Carcass cuts swab
- HCR- Half carcass rinse
- EWC- Enriched whole carcass

RoB- Risk of Bias

- L-Low RoB
- U- Unclear RoB

A2	(Berrang *et al.*, 2011)
A5	(Berrang, Windham and Meinersmann, 2011)
A6	
A9	(Sexton *et al.*, 2007)
A10	(Huezo *et al.*, 2007)
A14	(Uyarcan and Kayaardı, 2018)
A16	(Giombelli *et al.*, 2015)
A18	(Sanchez *et al.*, 2002)
A20	(Zhang *et al.*, 2011)
A21	(Berrang and Bailey, 2009)
A23	(Demirok *et al.*, 2013)
A24	(Whyte *et al.*, 2001)
A25	(Northcutt *et al.*, 2007)
A27	(Nagel *et al.*, 2013)
A29	(Bartenfeld *et al.*, 2014)
A30	(Singh *et al.*, 2017)
A31	(Cason, Buhr and Hinton, 2001)
A32	(McKee, Townsend and Bilgili, 2008)
A33	(Stopforth *et al.*, 2007)
A36	(Schambach *et al.*, 2014)
A38	(Russell, 2008)
A40	(Kemp *et al.*, 2001)
A42	(Russell and Axtell, 2005)
A45	(Northcutt *et al.*, 2008)
A49	(L. J. Bauermeister *et al.*, 2008)
A50	(Bilgili *et al.*, 2002)
A52	(Fabrizio *et al.*, 2002)
A54	(Northcutt *et al.*, 2005)
A55	(Bourassa *et al.*, 2005)
A56	(Yang, Li and Slavik, 1998)
A57	(Laura J. Bauermeister *et al.*, 2008)
A58	(Higgins *et al.*, 2005)
A59	(Özdemir and Pamuk, 2006)
A60	(Smith, Cason and Berrang, 2005)
A61	(Boubendir et al., 2021)
A62	(Kure et al., 2020)
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