Title: Interventions for *Salmonella* contamination in raw poultry products during processing: Protocol for a scoping review and evidence map

**Registration:**

The protocol will be made available at Systematic Reviews for Animals and Food (SYREAF) (http://www.syreaf.org).

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**Author contributions:**

Annette M. O’Connor conceived the idea, developed the protocol, and is the guarantor of the review.

Sarah Totton helped draft and revise the protocol and provided critique and refinement of the protocol.

**Amendments:**

None to report.

**Support: Source, sponsor, and role of funder:**

This review will be funded in part by a gift from the U.S. Poultry & Egg Association, which gave feedback to the review team during the development of the protocol. The U.S. Poultry & Egg Association will not influence the design or conduct of the review apart from helping determine cross-tabulation categories for the Evidence Gap Map.

**Conduct and reporting guidelines:**

We used PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) (Shamseer et al., 2015) and PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) (Tricco et al., 2018) when drafting this protocol.

# 1. Introduction

## 1.1. Rationale

 *Salmonella enterica* is responsible for the highest burden of foodborne disease globally (Kirk et al., 2015). In the United States, nearly one quarter (23.2%) of all foodborne *Salmonella* infections are attributable to eating poultry products (chicken or turkey) (Interagency Food Safety Analytics Collaboration, 2021). Further, recent outbreaks of *Salmonella* in Not Ready to Eat (NRTE) poultry products have prompted increased interest in mitigation strategies for *Salmonella* in raw poultry (Ford et al., 2023). Adequate prevention of infection involves all components of the farm-to-fork continuum, including processing (WHO, 2018).

 Information is needed on which types of processing interventions for reducing *Salmonella* contamination of raw poultry products have been studied, how often these have been tested, and gaps in the research literature on this topic. Scoping reviews are an evidence synthesis tool that can provide this information (Munn et al., 2018).

 A recent (1 August 2024) search of PubMed revealed a systematic review of ultrasound processing interventions on poultry meat (Al-Hilphy et al., 2020) and a 2012 systematic review of chilling interventions for broiler chickens (Bucher et al., 2012). More recently, Leone and others (2024) conducted a systematic review of chilling and post-chilling interventions against *Salmonella* in poultry during processing. We were unable to find a recent systematic or scoping review of processing interventions for *Salmonella* in raw poultry products apart from post-chilling and chilling interventions.

## 1.2. Objectives

 Our objective is to conduct a scoping review of mitigation strategies to reduce or eliminate *Salmonella* contamination during processing of raw poultry products.

# 2. Methods

## 2.1. Eligibility criteria

 We used the PCC framework (population, concept, context) (Tricco et al., 2018) for defining our eligibility criteria.

 Eligible population: Raw poultry products (chicken or turkey) intended for human consumption are eligible.

 Eligible concept: Eligible interventions are those that are applied during processing from slaughter, scalding/defeathering, rehang, evisceration, carcass washing, pre-chill, chill, post-chill, cutting into parts and comminution (mincing) that are intended to reduce *Salmonella* log CFU concentration. Eligible interventions should likely be relatively rapid (take < 30 minutes). Only those interventions that are permitted by the USDA’s Food Safety and Inspection Service are eligible. Ultraviolet, irradiation, and high-pressure processing pasteurization are eligible. Cloacal wash interventions are not eligible. Interventions applied during and after packaging are also not eligible.

 Eligible context/settings: Eligible settings include commercial poultry processing plants, pilot plants, and laboratory/experimental settings that mimic a commercial processing plant. Any studies conducted outside of these facilities (e.g., outside the processing plant after the product is comminuted, packaged and shipped) will not be eligible.

 Eligible study designs: Comparative challenge studies, randomized controlled trials as well as comparative natural contamination studies will be eligible (historical control OK). Only primary research will be eligible. Reviews, guideline documents and simulation models will not be eligible.

 Eligible study characteristics: Studies conducted in any country (provided they meet the standards of commercial processing) and in any year are eligible. As we do not have a budget for translation, only studies for which the full text is available in English will be eligible. Studies published in journals and conference proceedings (provided they have > 1000 words) will all be eligible.

## 2.2. Information sources

 The search will initially be conducted in PubMed and CABI (in the Michigan State University Web of Science interface). Validation of the search will be performed by checking the reference list of the recent systematic review on chilling and post-chilling interventions by Leone and others (2024) to ensure that the references cited by that review were captured by our search. We will then use Citation Chaser (https://estech.shinyapps.io/citationchaser/) (Haddaway et al., 2022) to identify other relevant studies, including any potentially relevant gray literature . The rationale for this approach is based on our experience with other reviews, which had incredibly diverse sources of articles. This approach provides the most comprehensive review of the literature.

 Also, we will hand-search the reference lists of all records passing full-text screening for any additional relevant references.

 We will not be contacting study authors for additional references. We will not be searching conference abstracts as the abstracts from the two that were considered most relevant to our topic (Poultry Science Association Annual Meetings, International Association of Food Protection Annual Meetings) are < 1000 words.

## 2.3. Search strategy

 Table 1 illustrates the search strategy for PubMed, which incorporates the PCC framework: 1) the study population (raw poultry products), 2) the context (*Salmonella* mitigation strategies), and 3) the setting/context (applied during processing). There will be no restrictions on date of publication or type of publication.

**Table 1.** Proposed search strategy in PubMed for a scoping review of interventions for *Salmonella* contamination in raw poultry products during processing (conducted on 23 December 2024).

|  |  |  |
| --- | --- | --- |
| **Search** | **Search string** | **Number of hits** |
| 1 (population) | chicken\* OR poultry OR broiler\* OR gallus\* OR turkey\* | 202,355 |
| 2(concept) | *Salmonella* [Title/Abstract] OR *Salmonella* [MeSH] | 103,200 |
| 3(concept) | rins\* OR disinfect\* OR spray\* OR wash\* OR dip OR decontaminat\* OR sanitize\* OR inactivat\* OR control\* OR limit\* OR intervention\* OR reduc\* OR antimicrobial OR inhibit\* OR prevent\* OR treatment\* | 16,082,269 |
| 4(context) | process\* OR product\* OR slaughter\* OR chill\* OR “post-chill” OR “postchill” OR eviscerat\* OR defeather\* OR scald\* OR receiving OR prechill OR “pre-chill” | 5,416,131 |
| 5 | #1 AND #2 AND #3 AND #4 | **3,016** |

Polyglot (https://sr-accelerator.com/#/polyglot) was used to translate the search string into CABI (Web of Science).

## 2.4. Study records

### 2.4.1. Data management

 Results of each search (PubMed and CABI) will be downloaded as RIS files, which will then be imported into online systematic review software (DistillerSR®, Ottawa, ON, Canada) and de-duplicated.

### 2.4.2. Selection process

 Screening of the search results will occur in two phases. In the first phase (Level 1 screening), each record will be screened based on the title and/or abstract, using a form created in DistillerSR®. Two reviewers (AMOC and SCT), working independently, will pretest the form on the first 100 records from the PubMed search before official screening begins. Subsequently, AMOC and SCT will independently screen the records found in the PubMed and CABI searches. Conflicts will be resolved via discussion. For the Citation Chaser search results, AOC and SCT will independently screen each of the first 500 records with any disagreements resolved by discussion. We will subsequently use AI as a second reviewer to complete the Level 1 screening. For the title/abstract screening, the following question will be used:

 **Q1.** Does the title and/or abstract describe primary research on one or more interventions to reduce *Salmonella* concentration on raw poultry products that are not comminuted, applied during relevant processing system?

* Yes (include for full-text evaluation)
* Unclear (include for full-text evaluation)
* No (exclude with no further review)

 Records for which the reviewers answered “Yes” or “Unclear” will move to the second phase of screening (Level 2 screening), during which the full text will be assessed for eligibility. Each record will be assessed by two reviewers (AMOC and SCT) working independently on a form which will be created in DistillerSR and pretested on five records. Conflicts will be resolved via discussion. The Level 2 form will be created in DistillerSR and will consist of the following questions:

 **Q1.** Is the full text available and longer than 1000 words?

* Yes (proceed to Q2)
* No (exclude)

 **Q2.** Is the full text in English?

* Yes (proceed to Q3)
* No (exclude with no further review) (specify language) \_\_\_\_\_\_\_\_\_

 **Q3.** Is this primary research?

* Yes (proceed to Q4)
* No (exclude with no further review)

 **Q4.** Is this research on raw poultry products (chicken or turkey) that are not comminuted and/or packaged?

* Yes (proceed to Q5)
* No (exclude with no further review)

 **Q5.** Is the outcome concentration of *Salmonella*?

* Yes (proceed to Q6)
* No (exclude with no further review)

 **Q6.** Is this a study of a relevant intervention (not cloacal wash, not chill, not post-chill) permitted by the USDA’s Food Safety and Inspection Service for use against *Salmonella* applied during processing (i.e., not on the farm, during or after packaging, during shipping, at retail or during kitchen preparation)?

* Yes (proceed to data charting)
* No (exclude with no further review)

Citation Chaser will be applied to all of the records passing Level 2 screening. Citation Chaser will also be applied to the set of studies identified by Citation Chaser that are found to be relevant. For the last set of citation chaser papers, we will use AI to screen out irrelevant studies and retain the “possible relevant papers” for review by AMOC and SCT. After completing this entire process, we will then use AI error detection to determine if citations that should have been considered have been inadvertently missed. This work will be conducted in DistillerSR. As no standards are available for using artificial intelligence in scoping reviews, we will use current best practices (O’Connor et al., 2018; O’Connor et al., 2019; O’Connor et al., 2020).

### 2.4.3. Data charting process

 The data charting form will be created in DistillerSR® and will undergo pretesting on three relevant references by both reviewers (AMOC and SCT). Subsequently, both reviewers will chart data from each relevant study, working independently and resolving any conflicts via discussion. Authors of the studies will not be contacted to confirm data or to provide additional information. Missing data will be scored as “Not reported.”

## 2.5. Data items

 We will extract the following variables from each relevant study (headings indicate where they will appear on the Evidence Gap Map):

Columns

* Country in which the study was conducted
* Setting of study (commercial plant, pilot plant, laboratory, etc.)
* Study design

Bubbles

* Type of poultry examined (chicken, turkey)
* Whether the intervention was applied to the whole bird or to parts of the bird (breasts, thighs, etc.)

Rows

* Stage of processing during which the intervention was applied (e.g., scalding, defeathering, etc.)
* Category of intervention(s) examined: physical, chemical, biological (e.g., bacteriophages)

## 2.6. Critical appraisal of individual sources of evidence

 This will not be done, as this is a scoping review.

## 2.7. Synthesis of results

 Descriptive statistics and tables will be used to summarize the data. In addition, charted data will be coded using EPPI-Reviewer version 4 (Thomas et al., 2023), then exported to EPPI-Mapper (Digital Solution Foundry and EPPI Centre, 2023) to create an Evidence Gap Map that cross-tabulates the data available on the topic and gives easy access to the information. Cross-tabulation categories will be determined after a closer literature evaluation and consultation with the U.S. Poultry & Egg Association stakeholders.

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