



Bacteria transferred to carcasses from scalders

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Abstract

An important food safety problem is bacterial contamination of poultry carcasses, which can happen at various phases of processing and slaughter. Because poultry carcasses are submerged in communal warm water prior to defeathering, the scalding stage is very crucial because it creates an environment where pathogens may be decreased by heat but may also be released into the scalding water and possibly transmitted to other carcasses. Thus, the goal of the current study was to look at how germs are transferred from scalding systems to poultry carcasses when they are being scalded. The study's specific objectives were to identify the kinds of bacteria found in scalding water and on poultry carcasses both before and after scaling, ascertain changes in bacterial load, evaluate the connection between scalding conditions and bacterial contamination, and determine the potential role of scalding water as a source of bacterial transfer.

A laboratory-based descriptive cross-sectional method was used. Samples of poultry carcasses were taken from specific poultry processing or slaughtering facilities both before and after the scalding operation, along with matching samples of scalding water. Standard microbiological techniques were used to isolate, count, and identify the microorganisms in the samples. While suitable inferential statistical tests were employed to evaluate variations in bacterial contamination between sample stages and sources, descriptive statistics were utilised to summarise the incidence and distribution of bacteria.

It is anticipated that the investigation will offer proof of bacterial contamination of poultry carcasses and scalding water, as well as elucidate whether the scalding environment may facilitate bacterial transmission and cross-infection. It is anticipated that the results would show that scalding may have two microbiological effects: heat exposure may help reduce germs, while contaminated scalding water and repeated contact with carcasses may offer chances for bacterial redistribution and cross-contamination. Throughout the chicken processing process, the study emphasises the significance of microbiological monitoring of scalding water, maintaining suitable scalding conditions, limiting organic matter, and implementing efficient hygiene and contamination-control procedures. By taking these steps, food safety during chicken slaughter and processing may be improved and bacterial translocation from scalding systems to bird carcasses may be decreased.

Keywords: Bacterial contamination; Poultry carcasses; Scalding; Scalding water; Bacterial transfer; Cross-contamination; Poultry processing; Food safety.

1. Introduction

Foodborne bacteria may proliferate and persist on carcasses during a number of stages of poultry slaughter and processing. Because carcasses are successively

submerged in warm water before defeathering, scalding is one of these processes that is particularly significant. The scalding water may serve as a channel for bacterial translocation across carcasses, even though the main purpose of scalding is to make feather removal easier and the high temperature can aid in the thermal inactivation of pathogens. Therefore, bacteria from tainted carcasses may get into the scalding water and cause other carcasses going through the same system to become cross-contaminated. The kinetics of bacterial transmission and inactivation during this step are crucial for poultry processing hygiene since modern industrial scalding systems typically entail many tanks through which grill carcasses travel consecutively. To lessen the possibility of foodborne bacteria spreading throughout the slaughter and processing chain, it is crucial to effectively limit microbial contamination during scalding.¹

Furthermore, the order of processing processes and operating circumstances may have an impact on the spread of bacteria during chicken processing. showed how the transmission and persistence of bacteria on chicken carcasses can be impacted by processing techniques like scalding, defeathering, and plucking. Their results highlighted the relevance of the processing environment in the redistribution and persistence of microorganisms by suggesting that changes in the bacterial communities linked to carcasses may occur during processing. Because microorganisms in scaling water may interact with corpses as they move down the processing line, the scalding environment was shown to be a crucial feature of the processing system. These results highlight the significance of regulating processing parameters and upholding suitable sanitary conditions throughout slaughter operations in order to reduce the spread and persistence of germs on poultry carcasses.²

Additional evidence from studies carried out directly along poultry slaughter lines has shown that bacterial contamination of carcasses is a dynamic process that varies across successful processing stages. Different microbial transmission patterns between the abattoir environment and chicken carcasses were found using both culture-dependent and culture-independent approaches in conjunction with microbial source-tracking analysis. According to their research, the microbial makeup of carcasses changed significantly after scalding, with thermophilic bacteria like *Anoxybacillus* and *Ureibacillus* being significantly more prevalent. After being scalded and defeathered, feathers also made a significant contribution to the microbial community of carcasses. The study emphasised that bacteria can be dispersed along the processing line by identifying scalding, defeathering, evisceration, and washing as crucial steps influencing the microbial structure of carcasses. In order to lessen the persistence and spread of bacterial contamination

¹ McCarthy, Z., Smith, B., Fazil, A., Ryan, S. D., Wu, J., & Munther, D. (2019). An individual-carcass model for quantifying bacterial cross-contamination in an industrial three-stage poultry scalding tank. *Journal of Food Engineering*, 262, pp.3 – 4.

² Chen, S. H., Fegan, N., Kocharunchitt, C., Bowman, J. P., & Duffy, L. L. (2020). Impact of poultry processing operating parameters on bacterial transmission and persistence on chicken carcasses and their shelf life. *Applied and environmental microbiology*, 86(12), pp. 11 – 12.

on poultry carcasses, these results highlight the significance of monitoring microbial transmission throughout effective slaughtering operations.³

When combined, these results show that interactions between carcasses and the processing environment throughout the slaughter line have an impact on bacterial contamination of poultry carcasses. Particularly when polluted water, equipment, or processing surfaces are involved, the constant flow of carcasses through subsequent processing stages may promote the persistence and redistribution of bacteria. Therefore, in order to improve sanitary procedures and lower microbial contamination of poultry carcasses before they enter future processing and storage stages, it is crucial to identify significant sites at which bacterial transmission may occur.

2. Research Problem

Because bacterial contamination may persist and spread during poultry slaughter and processing, particularly when carcasses are exposed to contaminated water and processing environments, bacterial transfer during scalding represents an important food safety concern. Previous studies have shown that scalding may contribute to the redistribution of microorganisms among poultry carcasses, as bacteria present on contaminated carcasses or within the processing environment may enter the scalding water and subsequently be transferred to other carcasses passing through the same system. Furthermore, variations in processing conditions and the sequence of slaughter operations may influence the transmission and persistence of bacteria on poultry carcasses. However, further investigation is required to clarify the role of scalders in bacterial transfer to carcasses and to determine the extent to which the scalding process contributes to bacterial contamination. Thus, the challenge of this study is to determine whether bacteria can be transferred from scalders to poultry carcasses during the scalding process and to provide evidence that may contribute to improved hygienic practices and microbial control during poultry processing. Thus, the primary research issue that the study aims to address is: **To what extent are bacteria transferred from scalders to poultry carcasses during the scalding process?**

3. Research Questions

- 3.1 What types of bacteria are present in scalding water and on poultry carcasses before and after the scalding process?
- 3.2 To what extent does the bacterial load on poultry carcasses change following exposure to the scalding process?
- 3.3 Does scalding water serve as a potential source of bacterial transfer to poultry carcasses?
- 3.4 Which processing conditions associated with scalding influence the transfer and persistence of bacteria on poultry carcasses?
- 3.5 To what extent does bacterial transfer during scalding contribute to the overall microbial contamination of poultry carcasses?

³ Jeong, J., Song, H., Kim, W. H., Chae, M., Lee, J. Y., Kwon, Y. K., & Cho, S. (2023). Tracking the contamination sources of microbial population and characterizing *Listeria monocytogenes* in a chicken slaughterhouse by using culture-dependent and-independent methods. *Frontiers in Microbiology*, 14, p.2.

4. Research Hypotheses

H1: There is a significant difference in the types and levels of bacterial contamination detected in scalding water and on poultry carcasses before and after the scalding process.

H2: The bacterial load on poultry carcasses increases significantly following exposure to the scalding process.

H3: Scalding water represents a significant potential source of bacterial transfer to poultry carcasses.

H4: Scalding operating conditions significantly affect the transfer and persistence of bacteria on poultry carcasses.

H5: Bacterial transfer during the scalding process significantly contributes to the overall microbial contamination of poultry carcasses.

5. Research Objectives

The specific objectives are to:

5.1 Identify the types of bacteria present in scalding water and on poultry carcasses before and after the scalding process.

5.2 Determine the bacterial load on poultry carcasses before and after exposure to the scalding process.

5.3 Assess whether scalding water represents a potential source of bacterial transfer to poultry carcasses.

5.4 Evaluate the effect of scalding operating conditions on the transfer and persistence of bacteria on poultry carcasses.

5.5 Determine the contribution of bacterial transfer during scalding to the overall microbial contamination of poultry carcasses.

6. Research Importance

Because contaminated poultry carcasses can be a source of human exposure if they are handled, processed, stored, or cooked incorrectly, bacterial contamination of carcasses is a significant food safety risk. Because carcasses are submerged in heated water and may come into touch with bacteria in the scalding environment, the scalding step is especially crucial. Contaminated scalding water may offer a pathway for bacterial translocation across carcasses, even though the main purpose of scalding is to make feather removal easier and may help inactivate bacteria through heat. In order to identify possible sources of microbial contamination during poultry slaughter and processing, it is crucial to ascertain whether germs are transported from scalders to bird carcasses.

Because scalding is an early stage of chicken processing where bacterial contamination may be disseminated among carcasses, the study is very important from a food safety standpoint. Evaluating bacterial transmission at this stage can assist in locating possible cross-contamination sites and assessing the efficacy of current processing and sanitary procedures. Developing more efficient preventive and control strategies may also benefit from an understanding of the connection between bacterial contamination in the scalding environment and contamination of poultry carcasses. Therefore, better cleanliness, process control, and microbiological monitoring during poultry slaughter and processing activities may be supported by the findings.

The dynamics of microbial transmission during this processing stage can also be learned by comparing the bacterial load and types of bacteria linked to scalding water and poultry carcasses before and after scaling. It may be possible to determine whether scalders serve as possible sources of bacterial transmission and whether certain operational settings affect bacterial persistence or redistribution by observing changes in bacterial contamination after exposure to the scalding environment. Slaughterhouse operators and food safety staff can utilise this information to identify crucial areas that need better hygiene and process control.

From a scientific standpoint, the study will add to the body of knowledge regarding the spread of germs during the slaughter of poultry, specifically the part scalding systems play in the spread and persistence of microbes on poultry carcasses. Future microbiological, veterinary, food safety, and poultry-processing studies examining bacterial contamination at specific stages of the slaughter process may use the results as a guide. Lastly, by offering evidence that can support the development of practical strategies for lowering bacterial transfer and cross-contamination during scalding and enhancing the overall microbiological safety of poultry carcasses, the results may be helpful to operators of poultry slaughterhouses, veterinary authorities, food safety organisations, and public health professionals.

7. Study Methodology

7.1 Study Design and Approach

The present study adopts a descriptive cross-sectional laboratory-based approach to investigate the transfer of bacteria from scalding systems to poultry carcasses during the scalding process. The study focuses on detecting and identifying bacteria present in scalding water and on poultry carcasses before and after exposure to the scalding process, determining changes in bacterial load, and assessing the potential role of scalding water as a source of bacterial transfer and cross-contamination. This approach is appropriate for providing a microbiological assessment of bacterial contamination associated with the scalding stage and for identifying potential points of bacterial transmission during poultry slaughter and processing.

7.2 Study Instruments

The main instruments used in the study include sterile sampling materials, sterile containers or swabs, microbiological culture media, laboratory equipment, incubators, and biochemical and/or microbiological identification tests used for the isolation and identification of bacteria from scalding water and poultry carcass samples. Appropriate laboratory materials are used for the collection, transportation, preparation, cultivation, and examination of the samples under aseptic conditions. A structured data-recording sheet is also used to document sample codes, sampling points, sampling stages, bacterial findings, bacterial counts, and other relevant laboratory observations. Where applicable, standard microbiological procedures are used to ensure the reliability and consistency of the laboratory results.

7.3 Sources of Data Collection

The study relies primarily on primary laboratory data obtained through the collection and microbiological examination of samples from scalding water and poultry carcasses during the slaughtering process. Samples are collected from selected poultry slaughtering or processing locations according to the sampling plan of the study. Carcass samples are obtained at appropriate stages of the scalding process, including before and after exposure to the scalding environment, while scalding-water samples are collected from the corresponding scalding system. Additional information relevant to the interpretation of the findings is obtained from scientific publications, previous microbiological and food safety studies, and relevant veterinary and poultry-processing references. These secondary sources are used to provide the scientific background and to compare the findings of the present study with previously reported evidence concerning bacterial transmission during poultry processing.

7.4 Study Sample

The study sample consists of poultry carcasses and scalding-water samples collected from the designated slaughtering or poultry-processing locations. Carcass samples are collected before and after the scalding process in order to evaluate changes in bacterial contamination associated with exposure to the scalding environment. Scalding-water samples are collected to determine the presence and level of bacterial contamination within the scalding system and to assess its potential role in bacterial transfer to carcasses. Samples are collected using appropriate aseptic procedures to minimize external contamination and are transported to the laboratory under suitable conditions for microbiological examination. Each sample is assigned a unique identification code to ensure accurate recording, traceability, and appropriate comparison between sampling stages.

7.5 Methods of Data Analysis

The collected laboratory data are analyzed using descriptive and inferential statistical methods. Descriptive statistics are used to calculate the frequency and percentage of bacterial-positive samples and to summarize the distribution of the identified bacterial groups according to sampling stage and sampling source. Bacterial counts obtained from carcass and scalding-water samples are summarized and compared before and after the scalding process. Where appropriate, the Chi-square test (χ^2) is used to examine statistically significant differences in the occurrence of bacteria between sampling stages or sources. Appropriate statistical tests may also be used to compare bacterial loads between carcasses sampled before and after scalding, depending on the nature and distribution of the collected data. The statistical significance level is set at $p < 0.05$.

7.6 Study Boundaries

The study is subject to the following boundaries:

Geographical boundary:

The study is conducted within the selected poultry slaughtering or processing location(s) from which the carcass and scalding-water samples are collected.

Population boundary:

The study focuses specifically on slaughtered poultry carcasses and scalding-water samples associated with the selected poultry-processing facilities.

Subject boundary:

The study focuses on the detection, identification, and quantification of bacterial contamination associated with scalding, particularly the potential transfer of bacteria from scalding water to poultry carcasses before and after the scalding process.

Laboratory boundary:

The microbiological analyses are limited to the culture, enumeration, isolation, and identification procedures and laboratory facilities available during the study period. The study does not necessarily include molecular characterization or advanced identification techniques unless these procedures are available and included in the experimental design.

Time boundary:

The study covers the period during which the poultry carcass and scalding-water samples are collected and analyzed in the laboratory.

Process boundary:

The study is specifically concerned with the scalding stage of poultry slaughter and does not primarily investigate bacterial transfer during other processing stages, such as defeathering, evisceration, washing, chilling, or packaging, except where such stages are considered for interpretation or comparison.

8. Literature Review

8.1 Bacterial Contamination of Poultry Carcasses

- **Definition of Bacteria**

Both Gram-positive and Gram-negative bacteria, some of which are regarded as significant pathogenic and foodborne pathogens, can be found in poultry. *Salmonella enterica*, *Campylobacter jejuni/coli*, and *Escherichia coli* are among the main Gram-negative bacteria linked to poultry, whereas *Enterococcus* species, *Staphylococcus* species, and *Clostridium perfringens* are significant Gram-positive bacteria. When these bacteria are found in poultry and items derived from chicken, they may be linked to bacterial illnesses in poultry and pose a risk to food safety. These bacterial groups' presence in poultry emphasises how crucial it is to manage bacterial contamination during the production and processing of poultry in order to lessen the possibility that contaminated food could spread harmful pathogens to people.⁴

⁴ Mak, P. H., Rehman, M. A., Kiarie, E. G., Topp, E., & Diarra, M. S. (2022). Production systems and important antimicrobial resistant-pathogenic bacteria in poultry: a review. *Journal of Animal Science and Biotechnology*, 13(1), p. 1.

Poultry's typical microbiota is made up of a variety of bacterial populations. It showed that commercial broiler chickens had a comparatively stable and predictable core bacterial microbiota, with bacterial communities found in the ileum, cecum, trachea, and surrounding litter environment. These bacterial communities are distributed across various tissues and body sites and may vary depending on the type of sample, the bird's age, and environmental conditions. The microbiota of poultry may harbor potentially pathogenic bacteria alongside beneficial bacterial populations, without necessarily causing overt clinical disease. These findings demonstrate that diverse bacterial communities naturally inhabit chickens and that the composition of these communities is crucial for understanding the presence, persistence, and potential contamination risks associated with bacteria during poultry production and processing.⁵

A significant bacterial species linked to poultry, *Escherichia coli* can be found in the typical bird bacterial community. However, some strains are known as avian pathogenic *Escherichia coli* (APEC) because they have pathogenic traits and cause colibacillosis in chickens. According to Panth (2019), avian colibacillosis is a significant endemic bacterial disease that affects the poultry industry and can manifest in several clinical manifestations. When assessing bacterial populations linked to poultry, it is crucial to distinguish between commensal *E. coli* and pathogenic APEC because the latter can cause systemic or localised infections in afflicted birds, while the presence of *E. coli* alone does not always indicate disease.⁶

Numerous bacterial infections that are significant from the standpoints of animal health and food safety can be found in chicken and products derived from poultry. *Salmonella* species, *Campylobacter* species, *Escherichia coli*, *Clostridium perfringens*, and *Listeria monocytogenes* are the main foodborne bacterial infections linked to chicken. Poultry may carry these bacteria, which could infiltrate the food chain and increase the risk of foodborne illness and zoonotic transmission. These bacterial diseases' existence and persistence in chicken production systems emphasise how crucial it is to manage bacterial loads during production and processing to lower contamination and safeguard public health.⁷

- **Bacterial Microbiota and Pathogenic Bacteria Associated with Poultry**

The gut microbiota, which includes bacteria, fungus, viruses, and protozoa, is a very diversified microbial population found in poultry. Among these microbes, bacteria make up the majority of the intestinal microbiota and are crucial for immune system development, digestion, nutritional utilisation, and intestinal health maintenance. Various parts of the chicken gastrointestinal

⁵ Johnson, T. J., Youmans, B. P., Noll, S., Cardona, C., Evans, N. P., Karnezos, T. P., ... & Lee, C. W. (2018). A consistent and predictable commercial broiler chicken bacterial microbiota in antibiotic-free production displays strong correlations with performance. *Applied and environmental microbiology*, 84(12), p2.

⁶ Panth, Y. (2019). Colibacillosis in poultry: A review. *Journal of Agriculture and Natural Resources*, 2(1), pp.301-303.

⁷ Sharma, S., Kaur, S., Naguib, M., Bragg, A., Schneider, A., Kulkarni, R. R., Nazmi, A., & Abdelaziz, K. (2025). Major foodborne bacterial pathogens in poultry: Implications for human health and the poultry industry and probiotic mitigation strategies. *Microorganisms*, 13(10), pp. 2 – 3.

system have quite varied bacterial community makeup and abundance. Lactobacilli, Enterococci, and Clostridiaceae are present in the jejunum, but Lactobacilli and Streptococci are frequently found in the crop and gizzard. While the ceca and cloaca are home to numerous and varied populations of bacteria, including Clostridium, Enterococcus, Ruminococcus, Streptococci, and E. coli, the ileum has a diverse bacterial community that includes Streptococci, Bacteroides, Clostridia, Escherichia coli, Ruminococci, Enterococci, and Lactobacilli.⁸

Poultry may include bacterial germs that might cause illness, even if many of the microbiota's members are commensal or helpful and support intestinal homeostasis. Through processes like competitive exclusion and prevention of pathogen colonisation, a balanced microbial population can help defend against harmful germs. On the other hand, harmful germs may proliferate or invade more easily if this microbial balance is upset. According to the review, necrotic enteritis brought on by Clostridium perfringens is one of the major infectious diseases that have an impact on poultry health. C. perfringens is a Gram-positive, anaerobic, spore-forming bacteria that can be found in birds' normal gut flora but can cause illness in the right circumstances. These results show that poultry can harbour a variety of bacterial populations, including commensal microorganisms and potentially pathogenic bacteria. Therefore, it is crucial to comprehend their presence and distribution in order to assess bacterial contamination during the production and processing of poultry.⁹

Chickens' gastrointestinal tracts are home to a varied and dynamic bacterial community that varies depending on the bird's age and the anatomical location of the digestive tract. According to Rychlik (2020), Lactobacilli predominately colonise the proximal portions of adult chickens' digestive tracts, but bacterial variety and community complexity dramatically increase in the distal portions of the intestinal system, especially in the colon and cecum. The cecum maintains a more complex microbial population than the small intestine, which has a relatively lower bacterial abundance and diversity. Escherichia coli is one of the first bacteria to colonise the cecum during the first week of a chicken's life. After that, other bacterial groups, such as those belonging to the Lachnospiraceae, Ruminococcaceae, Bacteroidetes, and Veillonellaceae, become more prevalent. Thus, a variety of bacterial groups that vary in quantity and distribution depending on the intestinal region and environmental exposure make up the composition of the chicken gut microbiota.¹⁰

⁸ Wickramasuriya, S. S., Park, I., Lee, K., Lee, Y., Kim, W. H., Nam, H., & Lillehoj, H. S. (2022). Role of physiology, immunity, microbiota, and infectious diseases in the gut health of poultry. *Vaccines*, 10(2), pp. 1 – 2.

⁹ Wickramasuriya, S. S., Park, I., Lee, K., Lee, Y., Kim, W. H., Nam, H., & Lillehoj, H. S. (2022). Role of physiology, immunity, microbiota, and infectious diseases in the gut health of poultry. *Vaccines*, 10(2), previous references, p. 2.

¹⁰ Rychlik, I. (2020). Composition and function of chicken gut microbiota. *Animals*, 10(1), pp. 8 – 9.

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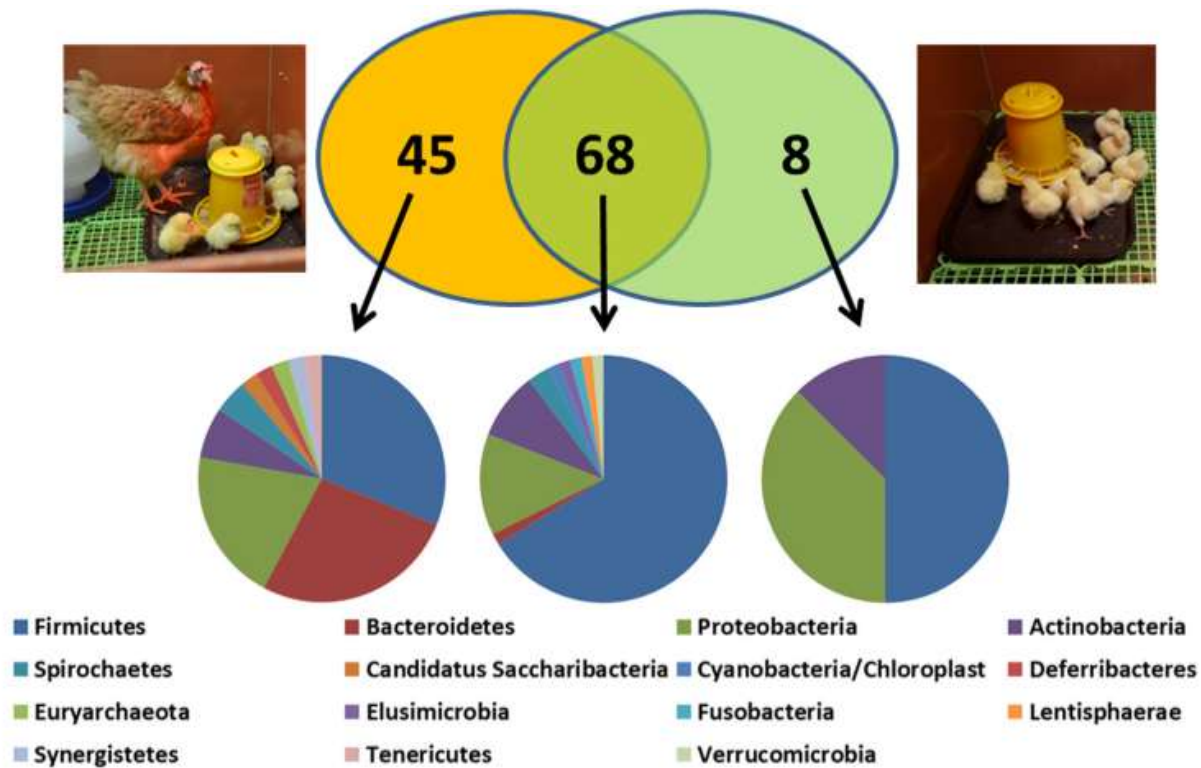


Figure 1 Bacterial genera of environmental or parental origin

As illustrated in **Figure 1**, the bacterial microbiota of young chickens comprises diverse bacterial genera originating from both environmental and parental sources. The distribution of these bacterial groups demonstrates that the bacterial community associated with poultry is influenced by the sources to which birds are exposed. Notably, genera belonging to Enterobacteriaceae, including *Escherichia*, *Proteus*, and *Salmonella*, were among the bacterial groups showing differences in abundance between contact and control chicks. These findings highlight the importance of environmental and biological sources in shaping bacterial communities associated with poultry.

8.2 Poultry Scalding Process and Scalding Systems

After the birds have been stunning and bleeding, a crucial step in the chicken slaughter process is scalding. Carcasses are then placed in a scalding tank as part of the processing procedure during commercial slaughter. Scalding is a separate step in the slaughter process that comes after the birds are killed, according to EFSA, which stressed that the birds' deaths should be observed and verified before they go into the scalding tank. As a result, the scalding stage, which involves exposing carcasses to heated water, serves as a crucial link between slaughter and later carcass-processing activities.¹¹

Prior to further processing steps, carcasses are submerged in warm water during the crucial stage of commercial poultry processing known as "scalding." The scalding procedure, water temperature, immersion time, and scalding system

¹¹ EFSA Panel on Animal Health and Welfare (AHAW), Nielsen, S. S., Alvarez, J., Bicout, D. J., Calistri, P., Depner, K., ... & Michel, V. (2019). Slaughter of animals: poultry. EFSA Journal, 17(11), pp. 8 – 9.

setup can all affect the scalding process's properties. Harris et al. (2018) assessed both hard and soft scalding procedures and looked at the impact of scalding time and water temperature on processing wastewater produced during broiler slaughter. Sequential scaling tanks were used in their research so that the effects of immersion conditions could be investigated at various stages of the scaling process. The results demonstrated that scale immersion duration was a significant factor related to processing wastewater loading, with longer immersion times exhibiting a tendency toward larger loadings of total solids, total suspended particles, and chemical oxygen demand. Additionally, the use of consecutive scaling tanks led to a decrease in wastewater loading throughout the processing system, although the first scaling tank had much higher organic and solid loading than succeeding tanks. These results show that the setup of the scalding system and the scalding circumstances can affect the scaling environment's characteristics, which is why they should be taken into account when assessing poultry processing processes.¹²

In poultry slaughter, scalding is a crucial processing step that is mostly used to release feathers prior to mechanical defeathering. Immersion scalding, which involves immersing carcasses in heated water, and steam or spray scalding are the two primary scalding methods used in chicken processing. According to Projahn et al. (2018), immersion scaling can help reduce bacteria by combining the cleaning activity of the water bath with the impacts of a higher temperature. However, when several carcasses are exposed to the same water environment during immersion scalding, there may also be a chance for cross-contamination. Steam scalding, on the other hand, is mostly dependent on the temperature action and is anticipated to have a reduced risk of bacterial cross-contamination. The authors also discussed various immersion-scalding situations, noting that mild scalding typically utilises lower temperatures and longer immersion intervals, whereas hard scalding typically uses higher water temperatures and shorter immersion times. These variations show that the efficiency of bacterial reduction as well as the possibility of bacterial transfer between poultry carcasses can be affected by the design and operation of scalding systems.¹³

A scalding tank is an important component of poultry processing equipment and is used to immerse slaughtered poultry carcasses in heated water before the feather-removal operation. The scalding operation facilitates the loosening of feathers and is closely associated with the efficiency of subsequent mechanical de-feathering. Ogunnowo et al. (2024) developed and evaluated a de-feathering machine incorporating an integrated scalding tank. The system consists of a heated scalding tank connected to a mechanical de-feathering unit, allowing the carcass to undergo scalding before entering the feather-removal stage. The main components of the fabricated system include the de-feathering and heating

¹² Harris, C. E., Gottilla, K. A., Bourassa, D. V., Bartenfeld, L. N., Kiepper, B. H., & Buhr, R. J. (2018). Impact of scalding duration and scalding water temperature on broiler processing wastewater loadings. *Journal of applied poultry research*, 27(4), pp. 523 – 524.

¹³ Projahn, M., Pacholewicz, E., Becker, E., Correia-Carreira, G., Bandick, N., & Kaesbohrer, A. (2018). Reviewing interventions against Enterobacteriaceae in broiler processing: using old techniques for meeting the new challenges of ESBL *E. coli*?. *BioMed Research International*, 2018(1), pp. 1 – 3.

units, structural frame, and mechanisms for handling and operating the machine. The configuration of these components is illustrated in **Figure 2**, which provides a visual representation of an immersion scalding system and its relationship with the subsequent mechanical de-feathering process.¹⁴



Figure 2 The fabricated de-feathering machine with scalding tank.

Source: Ogunnowo et al. (2024).

Figure 2 illustrates the main components of the fabricated de-feathering machine with an integrated scalding tank. **Number 1** represents the rubber fingers used to remove feathers from the poultry carcass during mechanical defeathering, while **number 2** indicates the 2-horsepower electric motor that provides the driving power for the machine. **Number 3** represents the de-feathering drum, which contains the mechanisms responsible for mechanical feather removal, and **number 4** indicates the feather outlet through which the removed feathers are discharged. **Number 5** represents the handle used for handling or operating the machine, whereas **number 6** indicates the wheel and axle system that facilitates movement of the equipment. **Number 7** represents the electrical wire associated with the machine, while **number 8** identifies the scalding tank, where the slaughtered poultry carcasses are immersed in heated water before defeathering. **Number 9** represents the supporting frame that holds the main components of the machine, and **number 10** indicates the 5.87-kW

¹⁴ Ogunnowo, O. A., ADEPOJU, V., Adisa, A. F., Dairo, O. U., Ismaila, S. O., & Babalola, A. A. (2024). Performance evaluation of a de-feathering machine with scalding tank. *Agricultural Engineering International: CIGR Journal*, 26(1), pp. 242 – 244.

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immersion heater responsible for heating the water in the scalding tank. Together, these components demonstrate the functional relationship between the scalding and mechanical defeathering stages, in which the carcass is first exposed to heated water and subsequently transferred to the de-feathering unit for feather removal.

Because insufficient or excessive heat exposure may compromise the quality of the treated carcass, scaling temperature and immersion time are crucial operational parameters in poultry processing. In a case study of temperature irregularities in scalding tanks, Priyantha and Senarath (2025) found that variations in scalding temperature were linked to variations in the qualitative attributes of processed poultry. In contrast to fowl exposed to 58°C for two minutes, which showed a normal colour and harder texture, the study found that extreme scalding at 64°C for three minutes caused discolouration and a softer meat texture. These findings highlight how crucial it is to maintain suitable and reliable scalding conditions when processing chicken. Therefore, temperature control is crucial for both aiding efficient feather removal and preserving the appropriate quality attributes of poultry carcasses.¹⁵

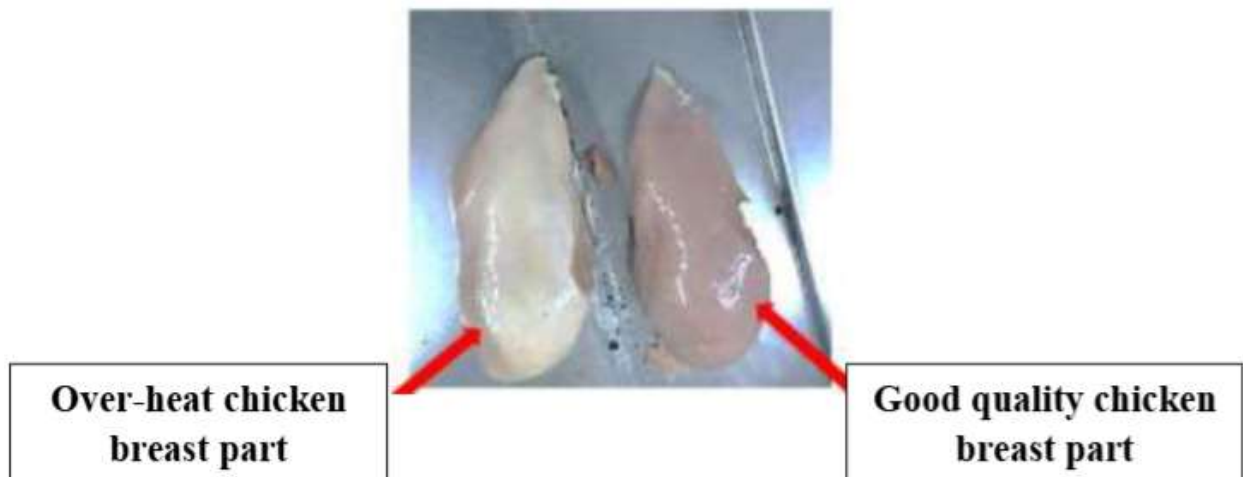


Figure 3 Comparison of Overheated and Good-Quality Poultry

The comparison presented in **Figure 3** further illustrates the effect of scalding conditions on poultry carcass quality and highlights the need for consistent temperature control throughout the scalding process.

Scalding tanks constitute an essential part of the poultry processing line, where slaughtered birds are immersed in heated water to facilitate feather loosening before mechanical defeathering. The design and operation of these tanks are closely related to the control of scalding temperature and processing conditions. Priyantha and Senarath (2025) highlighted the importance of maintaining consistent temperature conditions in scalding tanks, as temperature variations

¹⁵ Priyantha, H. R. D. A., & Senarath, B. T. D. N. (2025). Improving Quality Assurance in Poultry Processing: A Case Study on Overcoming Temperature Inconsistency in Scalding Tanks at Alpha's Poultry Plant. Sri Lanka Journal of Management Studies, 7(2), pp. 4 – 6.

may result in over-scalding or under-scalding and consequently affect the quality of processed poultry. The general configuration and appearance of scalding tanks used in poultry processing are illustrated in **Figure 4**.¹⁶



Figure 4 Scalding Tanks

The scalding tank therefore represents a shared processing environment in which multiple poultry carcasses may be exposed to the same heated-water system, making its operating conditions important not only for effective feather removal but also for controlling potential microbial transfer during processing.

Scalding conditions are crucial for minimising bacterial contamination during chicken processing as well as for efficient feather removal. The frequency of enteric pathogens and the quality of processed chicken can be affected by variables such as scalding time, water temperature, pH, and water flow direction, according to Lu et al. (2019). The authors pointed out that while immersion scalding at temperatures between 65 and 70°C might not be enough to eliminate *Campylobacter* on naturally contaminated carcasses, temperatures above 75°C might result in skin injury, discolouration, and a decline in the appearance of the carcass. The review also suggested that involuntary defecation during scalding and faecal material contamination of feathers could contaminate the scalding environment. These results show that the scalding tank is a crucial processing environment where temperature and other operational factors might

¹⁶ Priyantha, H. R. D. A., & Senarath, B. T. D. N. (2025). Improving Quality Assurance in Poultry Processing: A Case Study on Overcoming Temperature Inconsistency in Scalding Tanks at Alpha's Poultry Plant. *Sri Lanka Journal of Management Studies*, 7(2), previous references, p. 6.

affect bacterial survival as well as the possible redistribution of germs across poultry carcasses.¹⁷

8.3 Bacterial Transfer and Cross-Contamination during Scalding

By examining 22 grill processing lines that account for more than 90% of UK production, Hutchison et al. (2022) produced comprehensive field-based evidence of bacterial alterations and cross-contamination during commercial chicken processing. After exsanguination, scalding, defeathering, evisceration, inside-outside washing, and air cooling, among other processing steps, campylobacter levels were measured quantitatively. The results demonstrated that on 16 of the 22 processing lines, scaling led to a considerable decrease in Campylobacter counts. However, the reductions made during scalding on these lines were negated by the subsequent defeathering stage, which significantly increased Campylobacter infection. Crucially, the study also showed significant cross-contamination between flocks, with Campylobacter spreading from colonised flocks to uncolonized flocks that were later processed. This transmission persisted even after 5,000 carcasses from the previously uncolonized flock were processed, reaching up to 4 log CFU/g of neck skin. These results show that contamination can spread between successful carcasses or flocks during poultry processing, even though scalding may help reduce bacteria. This emphasises the significance of assessing the scalding stage in the larger context of microbial cross-contamination.¹⁸

Scalding can significantly reduce bacterial populations through thermal exposure, hence its impact on bacterial contamination extends beyond bacterial translocation. Hasty et al. (2018) assessed how well scalding reduced the populations of *Escherichia coli* surrogates that produced Shiga toxin on hide-on bob veal carcasses. The bacterial surrogate population was reduced by 2.1-log CFU/100 cm² after scaling at 60°C for 4 minutes in a conventional scalding tank. The reduction rose to 4.1 log CFU/100 cm² when scorching chemicals were added to the scalding water. These results show that bacterial decrease on carcasses can be greatly aided by scalding conditions. Cross-contamination is still a possibility, though, especially in shared scalding systems where microbes released from contaminated carcasses may enter the scalding environment and later interact with other corpses. As a result, the microbiological function of scalding should be viewed as a balance between the possibility of microbial transmission within the processing environment and bacterial inactivation.¹⁹

Understanding the microbiological state of scalding water is crucial to comprehending the spread of pathogens throughout the processing of chicken.

¹⁷ Lu, T., Marmion, M., Ferone, M., Wall, P., & Scannell, A. G. (2019). Processing and retail strategies to minimize Campylobacter contamination in retail chicken. *Journal of Food Processing and Preservation*, 43(12), pp. 2 – 3.

¹⁸ Hutchison, M. L., Harrison, D., Tchorzewska, M. A., Gonzalez-Bodi, S., Madden, R. H., Corry, J. E. L., & Allen, V. M. (2022). Quantitative determination of Campylobacter on broilers along 22 United Kingdom processing lines to identify potential process control points and cross-contamination from colonized to uncolonized flocks. *Journal of Food Protection*, 85(12), pp. 1696 – 1697.

¹⁹ Hasty, J. D., Henson, J. A., Acuff, G. R., Burson, D. E., Luchansky, J. B., Severt, N. J., ... & Thippareddi, H. (2018). Validation of a Sequential Hide-On Bob Veal Carcass Antimicrobial Intervention Composed of a Hot Water Wash and Lactic Acid Spray in Combination with Scalding To Control Shiga Toxin–Producing *Escherichia coli* Surrogates. *Journal of Food Protection*, 81(5), pp.762 – 763.

Peichel et al. (2025) assessed the presence of the pathogen in the scalding water and examined the survival of multidrug-resistant *Salmonella* Heidelberg on grill drumsticks under scalding conditions at 54°C for two minutes. After being exposed to low and high inoculum levels, respectively, *S. Heidelberg* was recovered from the scalding water in the untreated control groups at roughly 2.3 log CFU/mL and 4.0 log CFU/mL. These results show that during processing, harmful bacteria linked to poultry carcasses can infiltrate and remain in the scalding water. The study also showed that treatments with trans-cinnamaldehyde and peracetic acid could reduce or eradicate detectable *S. Heidelberg* in the boiling water, emphasising how crucial it is to manage the microbiological burden in processing water. Maintaining microbiological control of the scalding environment is crucial in minimising bacterial cross-contamination among poultry carcasses because tainted scalding water may serve as a medium for microbial propagation.²⁰

9. Results

- Detection of bacteria in scalding water and on poultry carcasses.
- Overall bacterial contamination during the scalding process.
- Bacterial load on carcasses before and after scalding.
- Distribution of bacterial contamination according to sampling stage.
- Identification of bacterial species associated with scalding.
- Bacterial contamination of scalding water during processing.
- Evidence of bacterial transfer from contaminated to uncontaminated carcasses.
- Occurrence of bacterial cross-contamination during scalding.
- Association between bacterial contamination and scalding conditions.
- Food-safety implications of bacterial transfer from scalders to poultry carcasses.

10. Recommendations

- Regular microbiological monitoring of scalding water during poultry processing.
- Routine testing of poultry carcasses before and after scalding.
- Maintaining appropriate scalding temperature and immersion time.
- Regular replacement or controlled renewal of scalding water.
- Effective removal of organic matter from scalding tanks.
- Proper cleaning and disinfection of scalding equipment and processing areas.
- Implementation of measures to minimize bacterial cross-contamination during scalding.
- Continuous monitoring of bacterial contamination along the poultry processing line.
- Training of poultry processing workers on hygienic scalding and contamination-control practices.

²⁰ Peichel, C., Nair, D. V. T., Manjankattil, S., Reed, K. M., Cox, R. B., Donoghue, A. M., & Johny, A. K. (2025). Effect of trans-cinnamaldehyde and peracetic acid alone or in combination on multidrug-resistant *Salmonella* Heidelberg on broiler drumsticks under scalding alone or with chilling and storage in sequence. *Journal of Applied Poultry Research*, 34(1), p.4.

- Development of effective food-safety control programs to reduce bacterial transfer from scalders to poultry carcasses.

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