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Absence of a continuous water spray system does not influence the microbiological contamination of the conveyor belts in chicken slaughterhouses

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ABSTRACT

The objective was to evaluate whether the absence of a water spray affects the microbial contamination on chicken conveyor belts in slaughterhouse. A total of 1280 samples from modular and smooth conveyor belts, with and without water spray, were evaluated in four slaughterhouses in Brazil. Superficial swabs of conveyor belts were performed at the indicated time periods (T_0 - 5:00 a.m; T_1 - 9:00 a.m; T_2 - 5:00 p.m.; and T_3 - 10:00 p.m.) and submitted to counting of mesophiles, Enterobacteriaceae, coliforms, and *E. coli*. The data were evaluated by measuring the increment (positive or negative) in contamination between the periods and comparing the means of the conveyor belts with and without water spray. On the modular conveyor belts, the absence of water spray allowed for a significant increase in the counts only in the T_2–T_3 interval for coliforms and *E. coli*. On the smooth conveyor belts, the absence of water spray allowed for a significant increase in Enterobacteriaceae counts only in the T_2–T_3 interval. At the other intervals, absence in the water had no influence on the indicator counts. These results demonstrated that the use of a water spray system on conveyor belts does not influence the contamination count.

1. Introduction

Slaughtering chickens and processing chicken meat requires a significant amount of water for successive washing of the carcasses using showers, which are installed before the clean areas, to reduce the temperature for cooling purposes and for maintaining the hygiene of the equipment and utensils used in the slaughterhouse.

Regardless of the operation, the objective is to reduce microbial contamination and to produce safe food. To achieve these quality parameters, the Brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA) directs poultry slaughterhouses to utilize approximately 30 L of water per slaughtered chicken (Brasil, 1998).

This considerable consumption of water has been a concern in the industry with respect to both economic (the cost of water and its use in subsequent treatment is significant) and environmental perspectives (discharging the effluents into the environment is harmful). In addition, water usage in slaughterhouses has been the focus of several studies and discussions because water is a limited essential resource and is scarce in many regions of Brazil and the world; it is the responsibility of the food industry to use it rationally (Barana, Botelho, Wiecheteck, Doll, & Simões, 2014; Casani, Rouhany, & Knøchel, 2005; UNESCO, 2001). In this regard, some slaughterhouses are reviewing their processes to optimize water usage in all stages of slaughter and food processing.

In chicken-cutting rooms, portions obtained from carcasses are transported by conveyor belts for optimizing technological processing, and to comply with the sanitary requirements imposed by MAPA, the

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surfaces of the belts must be continuously sanitized with a water spray system (Brasil, 1998). This system aims to avoid the accumulation of organic matter and to minimize contamination of new products processed on the same surfaces that have been contaminated (Bersot et al., 2012; Soares et al., 2014).

In addition to the excessive use of water in the sanitation process, water spray on the conveyor belts during the cut-handling process can substantially increase the formation of aerosols and dispersion of water particles by increasing the humidity, promoting the dissemination of microorganisms that contaminate the products. Moreover, alternative methods such as ultrasound and ultraviolet radiation have been tested (Axelsson et al., 2013; Tolvanén, Lunden, Korkeala, & Wirtanen, 2007), and even the exclusion of the water spray system has been proposed (Soares et al., 2014).

Thus, the objective of the present study was to evaluate whether the absence of a continuous water spray system for operational hygiene affects the counts of indicator microorganisms (aerobic mesophiles, Enterobacteriaceae, coliforms, and *E. coli*) found on conveyor belt surfaces in chicken slaughterhouses.

2. Materials and methods

2.1. Characterization of slaughterhouses and conveyor belts

The present study was performed in four chicken slaughterhouse cutting rooms located in the southern region of Brazil, and all of the slaughterhouses were registered with the Federal Inspection Service of the MAPA, were qualified for export, and slaughtered between 200,000 and 440,000 chickens daily. From each cutting room, modular (polyethylene) and smooth (polyurethane) conveyor belts used to transport the cuts from the boning of chicken carcasses were examined.

All conveyor belts were equipped with a water spray system used just prior to the point of contact with the chicken cuts to allow for operational surface cleaning at the beginning of the process.

Four conveyor belts were selected in each of the four cutting rooms, two modular (water spray on and off) and two smooth (water spray on and off), thereby allowing for comparison of the same conveyor belt type with or without continuous cleaning by water spraying (Fig. 1). The shutdown of the water spray system was authorized by the Federal Inspection Service of each slaughterhouse evaluated.

2.2. Sample collection

For sample collection, the counts of aerobic mesophiles, Enterobacteriaceae, coliforms, and *E. coli* were used as references based on the methodology suggested by Decision 471/2001 (EC, 2001).

For sampling, five distinct points on the surface of the operational in-motion conveyor belts were selected, and each point was sampled using a 20-cm^2 mold (5 × 4 cm), totaling 100 cm^2. The five swabs were pooled in a single Falcon tube containing 10 mL of 0.1% peptone saline solution (Fig. 2). Thus, each 1 mL corresponded to a sampling of 10 cm^2 of the surface. After sampling of 100 cm^2, new sampling was performed (duplicate) with an interval of 5 min between the first and second sampling. After conditioning in the Falcon tubes, the swabs were refrigerated (4 °C) until further analysis.

In each slaughterhouse, the samples were collected at four timepoints during two work shifts: T_0: 5:00 a.m.; T_1: 9:00 a.m.; T_2: 5:00 p.m.; and T_3: 10:00 p.m. Ten replicates of the experiment were performed at each slaughterhouse on each of the modular and smooth conveyor belts with water spray systems on or off. Thus, the experiment evaluated 1280 surface samples.

2.3. Microbiological analyses

For determining the numbers of aerobic mesophilic bacteria, Falcon tubes containing the swabs were homogenized on a vortex for 1 min. From this same tube, 1 mL of 10^{-1} and 10^{-2} dilutions were obtained and were inoculated in Petrifilm™AC (3M, St. Paul, MN – AOAC 990.12). Plates were incubated at 35–37 °C for 48 h. After counting the number of colonies, the result was expressed as log CFU/cm^2.

For determining the numbers of Enterobacteriaceae, the same dilutions obtained for the mesophile counts were inoculated in EB Petrifilm (3M, St. Paul, MN – AOAC 2003.01). Plates were incubated at 35–37 °C for 24 h. After counting the number of colonies, the result was expressed as log CFU/cm^2.

For determining the numbers of coliform and *E. coli*, the same dilutions were inoculated in Petrifilm™ EC (3M, St. Paul, MN - AOAC 991.14). Plates were incubated at 35–37 °C for 48 h. After counting the number of colonies, the result was expressed as log CFU/cm^2.

2.4. Data analysis

The data obtained from the bacterial counts were tabulated, and the increment was calculated between the time intervals evaluated (T_0, T_1, T_2, and T_3) for verifying the increase (preceded by "↑" in the tables) or decrease (preceded by "↓") in bacterial counts throughout the process of industrialization.

After obtaining the increment values, the Mann-Whitney test (Mann & Whitney, 1947). was applied for comparison of counts on the modular and smooth conveyor belts with and without water spray at different intervals. All analyses were performed using the statistical software IBM® SPSS® Statistics Version 20, using a significance level of 0.05.

3. Results and discussion

For modulator conveyor belts (Table 1), the water spray system did not affect the increment of the counts of mesophiles and Enterobacteriaceae between the intervals of evaluated times ($P > 0.05$). For coliform, the only interval wherein water spray affected the contamination increments during the process was between T_2–T_3 ($P = 0.017$), and in conveyor belts with spray (negative increment of −0.96 log CFU/cm^2), the increment was lower compared to that of the belt without spray (positive increment of −0.18 log CFU/cm^2). For the other intervals, the increment of indicator counts of the conveyor belts with and without spray did not present a significant statistical difference ($P > 0.05$).

For *E. coli*, no statistical differences were observed between T_0–T_1 and T_1–T_2 in modular conveyor belts with and without spray. For the T_1–T_3 interval, conveyor belts without spray presented higher increments than those with spray ($P = 0.05$); however, it should be noted that between T_1–T_3, the counts of *E. coli* decreased throughout the process (negative increment), regardless of whether or not spray was used on the conveyor belts. Between T_2–T_3, the increment was higher than in those without spray (positive increment of −0.57 log CFU/cm^2; $P = 0.024$).

Table 2 presents the increments in contamination on the smooth conveyor belts. The water spray system did not affect the increments of mesophiles and coliforms at any of the evaluated intervals ($P > 0.05$).

For Enterobacteriaceae, spray influenced the contamination counts in the T_1–T_2 and T_2–T_3 intervals. Between T_1–T_2, conveyor belts without spray presented a smaller increment compared to that presented by conveyor belts with spray ($P = 0.005$). However, between T_2–T_3, conveyor belts without spray exhibited a higher increment (positive increment of 0.32 log CFU/cm^2; $P = 0.004$).