BROILER CARCASS QUALITY AND SLAUGHTERHOUSE HYGIENE ASSESSMENT IN BLIDA (ALGÉRIA)

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Abstract. The slaughterhouse is where the greatest opportunities for carcass contamination occurs. The present study is a contribution to the evaluation of the hygienic quality of broiler carcasses by evaluating the hygienic state of a modern slaughterhouse (SM) and two traditional slaughterhouses (TS1, ST2) and the impact of good hygiene practices related to premises and slaughtering processes. To do this, a microbiological analysis was carried out by counting total germs, total coliforms and fecal coliforms on 156 surface samples and 30 neck skin samples from chicken carcasses. The results showed for chicken transport cages and the walls a strong contamination at the TS1 level for the microbial groups sought. The carcass contacts surfaces showed contamination for TS1 and TS2 for the microbial groups sought while at the MS level the Fecal coliforms were absent from the Manipulators hands, Knife, carts and Carcass box. Regarding the quality of the carcasses (neck skin), the average contamination for Total aerobic mesophilic is 7,782±0,050 log CFU/g and 4,795±0,034 log CFU/g and 3,545±0,088 log CFU/g average load The Total coliforms is 4,371±0,075 log CFU/g and 2,302±0,184 log CFU/g and 1,593±0,207 log CFU/g for carcasses from TS1, TS2 and MS respectively. For contamination by Fecal coliforms, carcasses from MS showed no contamination, however those from TS1 and TS2 showed an average load of 2,858±0,055 and 1,588±0,156 log CFU/g respectively. Compared to the quality of carcasses from MS, carcasses from ST1 and ST2 were significantly more contaminated ($P<0,05$). Although there are differences between the modern slaughterhouse and the killings, the main stages of slaughter are similar, however, hygiene strongly conditions the results obtained.

Key words: Carcass; broiler; hygiene; slaughterhouse; quality

INTRODUCTION

Widely consumed in Algeria, chicken represents an attractive product for the vast majority of the population of all social categories, given its cost which despite the fluctuations observed especially during religious holidays remains affordable compared to that of red meat. According to the Ministry of Agriculture, Rural Development and Fisheries (MDRP, 2018) the national production of white meat experienced a considerable evolution in 2017, reaching 5.3 million quintals (Mqt), against 2,092 Mqt in 2009, an increase of 153%.

The Algerian poultry industry which 90% dominated by the private sector has experienced a significant jump in less than a decade with a considerable animal wealth of 240 million broilers and turkeys. Increased production has made the country self-sufficient; however, quality is a more complex problem. In addition to the nutritional and organoleptic qualities, broiler meat must above all be a healthy product, that is to say free from pathogenic germs and dangerous for human health. Generally, classic ante or post mortem inspections are based on the detection of clinical or lesional signs and the removal of carcasses manifestly unfit for consumption. However, ensuring the microbial safety of poultry meat is an important issue. Microbial contamination of poultry carcasses can be influenced by many factors during transport and slaughter (Svobodová et *al*., 2012). During and after slaughter, bacteria from the animal microbiota, the environment of the slaughterhouse and the equipment used contaminate the carcasses (Rouger et *al*., 2017).

The present study is a contribution to the evaluation of the hygienic quality of broiler carcasses by assessing the hygienic state of a modern slaughterhouse and two traditional slaughterhouses and the impact of good hygiene practices related to the premises and the slaughter process.

MATERIALS AND METHODS

Our study focused on two traditional slaughterhouses and a modern slaughterhouse chosen in relation to their working methods and slaughtering process.
Slaughterhouse 1 (TS1): old building, traditional, does not have a slaughter line; there are neither hygienic conditions nor the cleaning and disinfection protocol.
Slaughterhouse 2 (TS2): old building, does not have a slaughter line, but there is compliance with hygiene conditions and the cleaning and disinfection protocol.
Slaughterhouse 3 (MS): Modern and new building, has a modern slaughter line, the building is designed according to the HACCP system with respect for hygienic conditions and the cleaning and disinfection protocol.

Sampling protocol

For hygiene assessment, the facilities were visited at the beginning and end of week. 156 swabs were collected from contact surfaces with the live animal (chicken cages) and with the carcass (Manipulators hands, knife, plucker fingers, carts and carcass box) as well as the environment (walls). The swabs were performed in duplicate, a first swab soaked in sterile physiological water solution followed by a second dry swab. The two swabs are put in the same tube with 20 ml of buffered peptone water (EPT, Institut Pasteur d'Algérie®).

For carcass quality, at each visit, we removed the skin from the neck for three carcasses, for a total of 30 samples. Sampling was carried out in the end of the slaughter line. 25g of the neck skin were put in identified sterile stomacher bags and added 225 ml of EPT.

All samples were sent to the analysis laboratory in icebox cooler.

Bacteriological analysis.

From the previously homogenized samples, appropriate serial decimal dilutions were prepared in EPT medium for enumeration of hygiene indicator microorganisms. Total aerobic mesophilic were enumerated using plate count agar (PCA, Pasteur Algérie®), after incubation at 30 °C for 72 h. Violet crystal and neutral red biliated

lactose agar (VRBL, Institut Pasteur Algérie®) was used to enumerate total coliforms and fecal coliforms after incubating plates at 30°C for 24h and at 44°C for 24h, respectively.

Statistical analysis

Statistical analysis was performed with the IBM SPSS, Statistic 21, software package. Data *were subjected* to one-way *analysis* of *variance* (*ANOVA*) and the *mean* values *were compared* using *Duncan's test*. Statistical significance was set at $p < 0,05$. Values were presented as the mean ± standard deviation (SD).

RESULTS AND DISCUSSIONS

Microbiological quality at reception

The results of microbial load of chicken transport cages in the three slaughterhouses are shown in Table 1. It was demonstrated that the highest bacterial load was found in TS1 compared to TS2 and MS. However, neither significant difference was recorded ($p > 0,05$), except for total coliforms.

Table 1

Mean and standard deviation of microbial loads of chicken transport cages for slaughterhouses (Values in log CFU / cm^2)

	MS	TS1	TS2
Total aerobic mesophilic	3,885±0,021[a]	7,8±0,042[b]	4,52±0,085[b]
Total coliforms	2,255±0,12[a]	4,71±0,042[b]	4,23±0,551[c]
Fecal coliforms	1,265±0,134[a]	3,76±0,014[a]	2,36±0,184[a]

For each microbial type, the values followed by different letters on the same line are significantly different ($p < 0,05$)

Microbiological quality of the environment

The results of microbial counts recorded in samples obtained from the walls in the three chicken slaughterhouses are presented in table 2. Samples from TS1 presented higher contamination when compared with those from TS2 and MS. For total aerobic mesophilic and total coliforms, significant differences were noted between the slaughterhouses, with exception for total aerobic mesophilic between TS1 and TS2.

Table 2

Mean and standard deviation of microbial loads in samples obtained from the walls of slaughterhouses (Values in log CFU/cm^2)

	MS	TS1	TS2
Total aerobic mesophilic	2,785±0,049[a]	8,6±0,098[b]	4,68±0,25[b]
Total coliforms	ND	3,715±0,091[a]	1,50±0,141[b]
Fecal coliforms	ND	1,13±0,070[a]	0,00±0,00[a]

For each microbial group, the values followed by different letters on the same line are significantly different ($p < 0,05$).

ND: not detectable.

Microbiological quality of carcass contacts surfaces

The results of microbial loads recorded in samples of carcass contact surfaces in the three chicken slaughterhouses are reported in table 3. For all microbial groups enumerated, TS1 has a great microbial load in all carcass contact surfaces analyzed, followed by TS1 and MS. About total aerobic mesophilic, significant differences ($p<0,05$) were noted between slaughterhouses for all contact surfaces, except between TS1 and TS2 for manipulators hands. While, for total coliforms, no significant differences were detected between the TS1 and TS2 for all contact surfaces. As for fecal coliforms, their presence was reported only in the TS1 in all contact surfaces and in the TS2 for manipulators hands and plucker fingers.

Table 3

Mean and standard deviation of microbial loads in samples of carcass contact surfaces from slaughterhouses (Values in log CFU/cm^2)

	MS	TS1	TS2
Manipulators hands			
Total aerobic mesophilic	2,73±0,049^a	6,8±0,14^b	4,91±0,007^b
Total coliforms	ND	2,08±0,34^a	1,825±0,106^a
Fecal coliforms	ND	1,68±0,113^a	1,46±0,09^b
Knifes			
Total aerobic mesophilic	2,785±0,049^a	8,6±0,098^b	4,68±0,25^c
Total coliforms	0,00±0,00^a	3,715±0,09^b	1,50±0,14^b
Fecal coliforms	ND	1,13±0,070	ND
Plucker fingers			
Total aerobic mesophilic	3,666±0,046^a	8,241±0,509^b	4,601±0,525^c
Total coliforms	2,65±0,208^a	4,29±0,124^b	3,60±0,105^b
Fecal coliforms	1,46±0,227^a	3,58±0,241^a	2,73±0,180^b
Carts			
Total aerobic mesophilic	2,772±0,06^a	4,81±0,047^b	3,44±0,088^c
Total coliforms	1,32±0,029^a	2,53±0,389^b	1,93±0,082^b
Fecal coliforms	ND	1,91±0,076	ND
Carcass box			
Total aerobic mesophilic	2,768±0,150^a	5,588±0,118^b	3,785±0,244^c
Total coliforms	1,565±0,124^a	2,693±0,177^b	1,928±0,036^b
Fecal coliforms	ND	1,949±0,020	ND

For each microbial group, the values followed by different letters on the same line are significantly different ($p <0,05$).

ND: not detectable

Microbiological quality of the carcass

The results of microbial loads recorded from chicken's neck skin samples in the three slaughterhouses are summarized in table 4. The neck skins samples from TS1 were significantly more heavily contaminated by total aerobic mesophilic and total coliforms compared to those from TS2 and MS ($p<0,05$). For fecal coliforms, no significant difference has been observed between TS1 and TS2 ($p<0,05$).

Table 4

Mean and standard deviation of microbial loads in chicken neck skin samples in slaughterhouses (Values in log CFU/g)

	MS	TS1	TS2
Total aerobic mesophilic	3,545±0,088[a]	7,782±0,050[b]	4,795±0,034[c]
Total coliforms	1,593±0,207[a]	4,371±0,075[b]	2,302±0,184[c]
Fecal coliforms	ND	2,858±0,055[a]	1,588±0,156[a]

For each microbial group, the values followed by different letters on the same line are significantly different ($p < 0,05$).

ND: not detectable.

The current inspection practice of broiler carcasses does not make it possible to verify that the hygiene of the slaughter process is controlled. This non-compliance with the hygiene criteria could have an impact on the consumer health by transmission of pathogenic germs and on final quality of product, which can be deteriorated by bacteria leading to color, odor, taste and texture defects and consequently economic losses (Rouger et *al*., 2017). To transform a live bird into meat it involves a series of specific steps. The slaughter process consists of a succession of different operations and is of crucial importance for meat hygiene. Although there are some differences practices between modern slaughterhouse and traditional slaughterhouse, the main steps in the slaughter of poultry are similar. However, hygienic practices strongly condition the results obtained. In Algeria, a study by Alloui et *al*. (2013) by questionnaire showed two categories of slaughter, 16,67% respected certain slaughter rules and standards and 83,33% were characterized by unsatisfactory hygienic practices.

The ultimate quality of the final product depends not only on the condition of the birds when they arrive at the plant, but also on how the bird is handled during processing (Kiepper, 2012). Broilers arriving at the poultry slaughterhouse are highly contaminated with various microorganisms, including pathogens such as *Salmonella* and *Campylobacter spp.* (Göksoy et *al*., 2004). This initial charge can be explained by the *poor hygienic* practices at the farm and during transport. Various microbiota is housed in digestive tract, lungs, skin, feathers and on legs according to the study by Borges et *al*. (2019), a large proportion (52.6%) of cloacal samples were positive for *Salmonella*, this may explain the contamination of the cages of transport at the reception in our study.

In slaughterhouses, the surfaces, air (aerosols), and liquids also encompass bacteria. Therefore, carcasses and cuts after animal killing can be contaminated by animal and slaughterhouse environment microbiota (Rouger et *al*., 2017). This cross contamination in slaughterhouses has been reported by Rasschaert et *al*. (2008), who studied the relationship between the gastrointestinal colonization of birds by *Salmonella* and the contamination of carcasses after slaughter. They showed that the carcasses of 31 broiler flocks (55%) were contaminated after slaughter although only 7 broiler flocks (13%) were colonized with *Salmonella*. This indicates possible cross-contamination of slaughter equipment or cages of transport. Cross-contamination during transport and slaughter process was also highlighted by the study of *Campylobacter spp* of dirty and clean transport cages, in boiling water, as well as on the plucker and on the table (Perez-Arnedo & Gonzalez-Fandos, 2019).

Thus, scalding, plucking and evisceration are critical points in cross-contamination of carcasses (Chaiba & Rhazi Filali, 2011). Although plumage tends to reduce bacterial numbers on chicken carcasses (Göksoy et *al*., 2004). Scalding water not renewed and poorly maintained feathery are all favorable factors for the development of a number of microorganisms (Chaiba & Rhazi Filali, 2011). Although in the present study there were no samples taken from the scalding basins, but at the traditional slaughterhouse (TS1) it was found that the water was not renewed, which was very dirty at the end of the process. The rubber fingers of the pluckers constitute a privileged site of retention and development of germs. Thus, the porous structure of the rubber promotes this retention. Contact fingers with the carcasses contributes to the penetration of microorganisms into feathery follicles. This makes their elimination difficult when washing carcasses (Salvat, 1997). Evisceration also contributes to contamination of carcasses with feces (Kiepper, 2012). Washing with cold water at the end of the trial after evisceration can serve as a vehicle for cross-contamination between carcasses but can also have a decontaminating effect by rinsing the surface of the carcasses. According to Maharjan et *al*. (2019), It was observed that the level of microbial load decreased with subsequent processing phases in poultry processing plant where high level of bacteria was reduced during final washing and frozen phase. As well as the study by Svobodová et *al*. (2012) showed that total viable counts (TVC) and *E. coli* decreased during treatment, going from 4,6 log CFU/cm2 and 3,5 log CFU/cm2 to 3,7 log CFU/cm2 and 1,8 log CFU/cm2 respectively, with a major impact of washing on TVC and washing and cooling on decrease of *E. coli* ($P<0,001$). Moreover, the lack of effective disinfection of bench tops, work tools and staff hands promote carcass cross-contamination.

Contamination of broiler carcasses has been reported by several studies. According to Kuria et *al*. (2021) The average concentration of CFU/ml in the carcass was $1,59 \times 10^7$, $1,44 \times 10^5$, $3,2 \times 10^4$ and $1,06 \times 10^4$ for TVC, coliforms, *S. aureus* and *streptococci*, respectively. The *Campylobacter* genus was identified in 27,5% carcasses and *Campylobacter jejuni* in 7,5%. However, *Salmonella* was not isolated from any carcasses. The study by Zweifel et *al*. (2015) showed at the end of the slaughter process, in the cooler the loads of TVC, *Enterobacteriaceae*, *E. coli* and *Campylobacter* varied in the three slaughterhouses respectively from 4,2 to 4,4 log CFU/g, 2,8 to 3,5 log CFU/g and 2,5 to 3,4 log CFU/g.

It is obvious from these studies that the quality of carcasses depends on numerous parameters linked to the health state of the animal; and the slaughter process.

CONCLUSIONS

Controlling the health safety of poultry meat remains dependent on hygienic conditions during the slaughter process but also on improving farming conditions to minimize the health risk dominated by *Salmonella* and *Campylobacter*. The application of good hygiene practices in poultry slaughterhouses has become an absolute necessity for its direct impact on the safety and wholesomeness of carcasses.

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