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Risk Assessment Regarding the Contamination of Poultry Meat with Salmonella in a High-Capacity Slaughterhouse

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RESEARCH ARTICLE

Abstract

The frequency of salmonellosis in Europe remains high, being considered the second most common foodborne disease. Salmonella spp., was most commonly detected in poultry meat mainly in fresh turkey meat (3.5%) and fresh chickens (2.2%). The study aims to identify the level of contamination of poultry meat with Salmonella spp. and performing a risk assessment. The samples were collected from a large capacity slaughterhouse on two slaughter lines, from two groups of poultry. An antemortem and postmortem examination was conducted and the samples collected from the neck of poultry carcasses were analyzed using the VIDAS® bioMérieux automatic test using analytical technique. The results of the antemortem inspection indicated negative results. The postmortem examination on group I and group II indicated different types of lesions. The surveillance of contamination of poultry meat with germs of the genus *Salmonella* spp. highlighted 397 compliant samples in group I, out of a total of 403 samples and 6 non-compliant samples. *Salmonella infantis* was identified in these non-compliant samples following laboratory examination. The lesions associated with Salmonella infection are not specific and therefore there is no direct correlation between the results of laboratory examination and lesions.

Keywords: poultry meat; laboratory examination; contamination; Salmonella; public health

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INTRODUCTION

Nowadays, poultry is one of the most consumed meats both nationally and internationally, being the second most consumed meat in the European Union, after pork. Poultry meat can be considered a "Functional Food" which provides substances with a beneficial effect on human health, such as conjugated linoleic acid (CLA), vitamins and antioxidants (Barroeta,2006; Givens,2009). Human salmonellosis remains the second most commonly reported foodborne disease in Europe after campylobacteriosis (EFSA/ECDS,2015). Non-typhoidal *Salmonella* spp. are the main causes of foodborne illnesses. However, it is difficult to attribute an illness to a specific group of bacteria or food category, except during an outbreak of a foodborne illness (O'Bryan, 2021). The statistical data shows that 14% of salmonellosis are linked with the consumption of poultry meat (Interagency Food Safety Analytics Collaboration IFSAC, 2017). Approximately 40.000 Salmonella infections are confirmed by culture, serotyped and reported to the Centers for Disease Control and Prevention in each year. 96% from salmonellosis cases are considered as food born diseases (Mead.,1999). Salmonella infections represented 30.7% of all food poisoning infections during

2018, causing 11.581 diseases, increasing with 20,6% compared to 2017 (EFSA, 2018). There are currently over 2.500 recognized serotypes of *Salmonella enterica*, all of which are thought to be capable of causing disease in humans. Only about 10% from the 2.500 Salmonella serotypes were isolated from birds (Gast, 2008). *Salmonella enteritidis* is the predominant serotype (Eyigor, 2005). There are numerous vectors that can introduce *Salmonella* to the cycle of production of the poultry meat. The most important ones are the living carriers, like rodents and insects but the infected water and the litter play also an important role in this contamination (O'Bryan et al., 2021). It was demonstrated that *Salmonella* can survive for weeks in low water activity environments and can develop a tolerance to disinfectants due to cross tolerance (Finn, 2013).

Carcasses can be contaminated during the mechanical steps of the meat processing (scalding, picking, evisceration, and immersion). The main sources of the cross contamination are represented by the ruptures of the ceca and intestines and their content overflow (Blevin, 2018).

The examination of the carcasses is an important tool to assess the quality of the production system. In order avoid the contamination of the carcasses with Salmonella, the producers should follow good processing practices, implement Hazard Analysis Critical Control Point HACCP plans and should educate the consumers (Leighton, 2015). Nowadays, the major problem to public health is represented by the spread of Salmonella serotypes which are resistant to different antimicrobial products. Collineau et al. (2020) developed a quantitative risk assessment model in order to assess the risk generated by the resistant strains and to evaluate the effect of risk management measures.

The aim of the study was to perform an antemortem, postmortem examination or carcasses completed with a bacteriological exam of poultry meat samples in order to evaluate the level of contamination with *Salmonella* germs and to highlight the main aspects of a risk assessment.

MATERIALS AND METHODS

Sample collection

The samples were provided from a large capacity slaughterhouse with two slaughter lines. A total number of 403 laboratory samples were analyzed. The samples were collected from the neck region of broiler chickens using sterile containers and instruments. These samples were collected from both individual carcasses and mixed carcasses from these birds. For the detection of germs of the genus Salmonella spp. the alternative methods and analytical method using VIDAS® bioMérieux SLM automatic test were used.

Ante-mortem examination of the broilers

The ante-mortem examination was carried out in two groups. The first group (batch I) of broilers arrived to the slaughterhouse at 4:30 AM and the second group of broilers (batch II) arrived at the slaughterhouse at 9:30 AM. All conditions of welfare were fulfilled. Their welfare was evaluated, followed by all the necessary documentation (single register, sanitary- veterinary authorization, batch file, welfare monitoring register, consultations and treatments, analysis bulletin file, disinfection and sanitation report).

Postmortem examination of poultry carcasses

This examination was carried out in two groups and various lesions were reported.

Isolation and identification of Salmonella spp.

The detection of Salmonella spp. was carried out using the VIDAS® bioMérieux automatic test (SLM). The following protocol was used:

1) 25 g of sample was cut in pieces and homogenized with the Stomacher equipment.
2) For pre-enrichment 1 ml of sample was combined with 225 ml peptone water broth and incubated 24 ± 2 h at 35˚C.
3) For enrichment, 1 ml of suspension was transferred in 10 ml of RVS broth; the incubation last for 6-8 h at 41,5 ± 1˚C. 1 ml of suspension was transferred in 10 ml MKTTn broth; the incubation last for 6-8 h at 37 ± 1˚C.
4) For post-enrichment: from the RVS broth 1 ml of suspension and from the MKTTn broth 0,1 ml of suspension is transferred in 10 ml M Broth. Each swab was incubated for 16-20 h at 41,5 ± 1˚C.
5) After the incubation was finished, 1 ml of suspension from each swab was transferred into one tube. The tube was closed sealed and was heated for 15 min on a water bath at 95-100˚C. After that, the samples were cooled for 10 minutes.
6) 500 µl of broth M was added in the reagent strip of VIDAS® SLM and the rest of the broth was kept at 2-8˚C for the confirmation of the positive samples. The reagent strips were noted with numbers corresponding to each sample. The information regarding the tests (for the blank and samples) were introduced using code SML. The tests were run separately. Using the enriched broths which gave positive results VIDAS®

SLM, kept at 2-8 °C, the confirmation was conducted according to ISO 6579-1/2017 Microbiology of the food chain — Horizontal method for the detection, enumeration and serotyping of Salmonella — Part 1: Detection of Salmonella spp.

RESULTS

Results of antemortem and postmortem examination

The ante-mortem examination performed on the two groups, aimed at document control and negative certification at the bacteriological examination in the direction of salmonellosis and assessment of health and well-being, and it certifies results in accordance with specific legislation. The results of the ante-mortem inspection carried out on the holding of origin were consistent, including with negative results of testing for salmonellosis. Two groups of poultry were organized based on the batch of broilers who arrived to the slaughterhouse on different hours mentioned. Those broilers were originated from the same farm but from different halls.

In group I, 24.511 carcasses belonging to line I were subjected to the postmortem examination, of which 3 were rejected and another 505 carcasses presented various lesions: bruise/fractures (14.25%), contaminated viscera (11.48%), ascites/edema (10.49%), cellulitis (20.30%), tumors (2.57%), peritonitis/perihepatitis (4.75%), pericarditis (3.36%), overload (0.19%), hepatitis (10.69%), dermatitis (1.38%) , poor plucking (0.79%), death before slaughter (0.39%), death on arrival (2.57%), contaminated (2.97%), fever (4.75%) (Figure 1 and Figure 2).

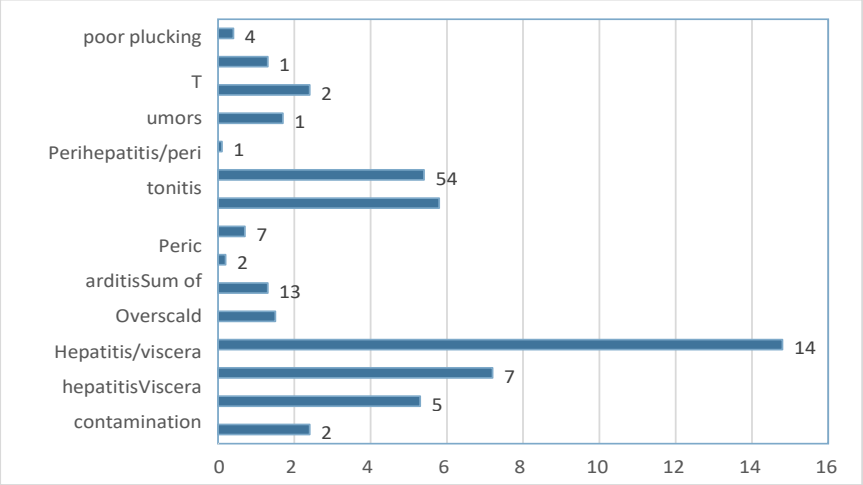

Figure 1. Lesions expressed in the postmortem examination of group I

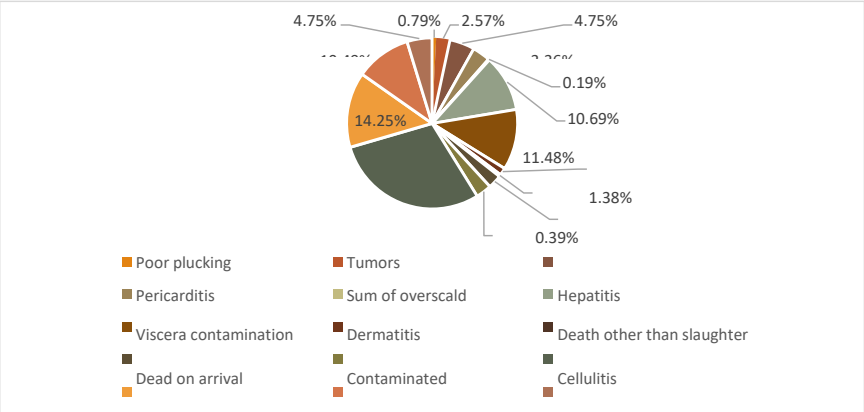

Figure 2. Scheme for results obtained in batch I at the postmortem examination

In group II, 63.036 carcasses belonging to line II were subjected to the postmortem examination, of which one carcass was rejected and another 503 carcasses presented various lesions: bruises/ fractures (6.75%), contaminated viscera (28.23%), ascites/edema (10.93), cellulitis (14.91%), tumors (1.39%), peritonitis/perihepatitis (4.57%), pericarditis (0.39%), overload (2.98%), hepatitis (3.57%), dermatitis (0.79%),

mild plucking (1.98%), death before slaughter (0.99%), death on arrival (3.77%), contaminated (10.93), fever (7 , 75%) in (Figure 3 and Figure 4).

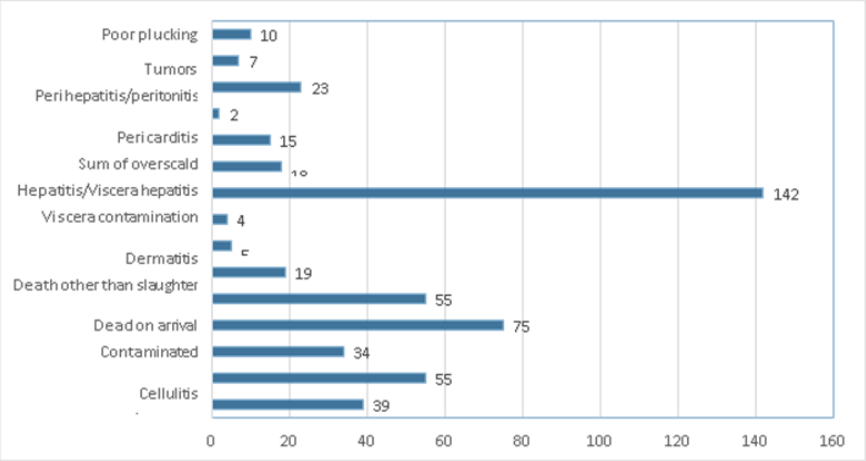

Figure 3. Lesions expressed in the postmortem examination of group II

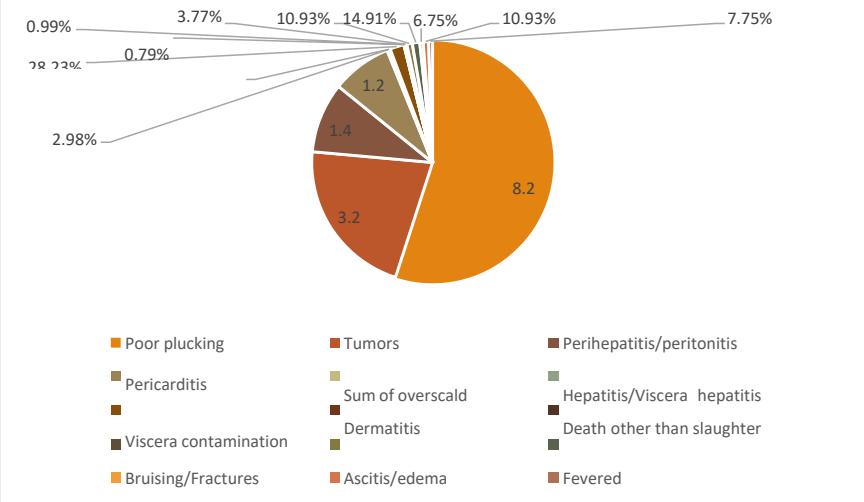

Figure 4. Scheme for results obtained in batch II at the postmortem examination

Surveillance of contamination of poultry meat with germs of the genus Salmonella spp.

In order to monitor the contamination of poultry meat with germs of the genus Salmonella spp., a total of 403 samples were analyzed. These samples came from the broiler slaughter line I category. The results showed that 397 samples were compliant and 6 non-compliant. *Salmonella infantis* was identified in these non-compliant samples following laboratory examinations (Figure 5).

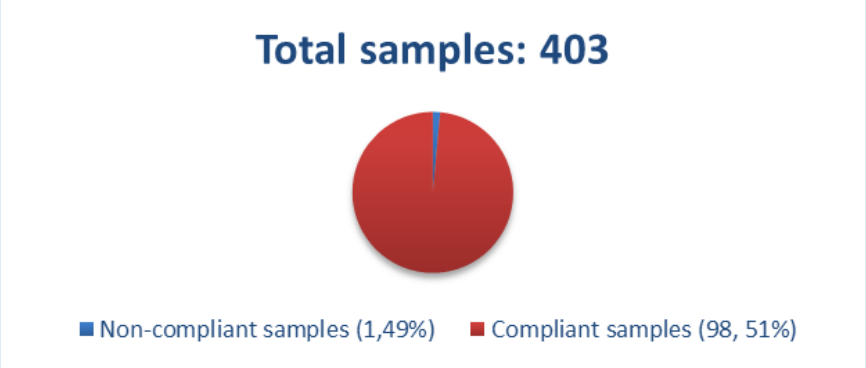

Figure 5. Scheme for the results of surveillance for the contamination of poultry meat with germs of Salmonella spp.

DISCUSSIONS

The level of contamination of the poultry carcasses with *Salmonella spp*. is influenced by several risk factors. The first risk factor that can be associated with the contamination of carcasses with Salmonella spp. is the transportation of the animals from the household to the slaughterhouse. These bacteria can grow at a temperature of 45˚C and therefore the probability of contamination can be higher in hot seasons. It is important to follow all the requirement necessary for the welfare of poultry during their transport. The time of transportation can also influence the level of contamination: extended time can lead to cross contamination with Salmonella from feces (Chih-Hsien Lin, 2021). Other risk factors are represented by the slaughtering operations. The requirements during washing, immersion and chilling are the most important because they can prevent a high level of contamination. For example, the use of citric acid can lead to a risk reduction of 2.7 * 10-9 (Xingning Xiao, 2021) but its use has also a limitation because it can have a negative effect on the sensory characteristics of the meat.

There are no specific lesions associated with the presence of *Salmonella spp*. on the carcasses of poultry. Therefore, a direct correlation between the described lesions and the results of bacteriological analysis is not clear enough.

The results of EFSA report indicated that the incidence of salmonelosis in poultry does not have a decreasing tendency (EFSA, 2018). Salmonella is the most frequently reported causative agent of zoonoses in the European Union (EU). *Salmonella spp*. is causing the highest number of hospitalizations among humans (49% of all hospitalizations). Six countries from the EU reported an increase over 25% of *Salmonella enteritidis* outbreaks: Estonia, Romania, Denmark, the Czech Republic, Lithuania and Germany (EFSA, 2018). Thus, there is a need for further research to manage the presence of Salmonella spp.

Bird et al. (2013) found out that a total of 475 samples were positive to *Salmonella spp*. from a total number of 826 analyzed samples. The samples used in their studies were represented by raw ground beef. On the other hand, Crowley et al. (2011) analyzed different food matrixes (liquid egg, vanilla ice cream, spinach, raw shrimp, and peanut butter): 1583 samples were analyzed, of which 792 were paired replicates with 285 positive results and 791 were unpaired replicates with 341 positive results. Both of them recommended the use of VIDAS method in order to detect Salmonella spp. in a variety of foods.

CONCLUSIONS

Salmonellosis in poultry is still a real threat for public health. The surveillance by direct examination in order to identify Salmonella spp. is important for the prevention of diseases and management of public health. In order to detect Salmonella spp., the samples were collected from a large capacity slaughterhouse with two slaughter lines and automated methods have been applied. The lesions presented on the poultry carcasses were not specific to the infection with Salmonella spp. The number of positive samples indicating the presence of Salmonella spp. was 6, which reveals a level of contamination of 1,49%.

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Conflicts of Interest: The authors declare that they do not have any conflict of interest.

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