Food chain information systems in medium- and small-sized slaughterhouses of central Italy and organ and carcass condemnations: A five-year survey

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Abstract

The flow of information between farms and slaughterhouses about animal health, is a fundamental process for modern meat inspection. The information provided by Food Chain Information (FCI) systems in medium-small sized slaughterhouses in central Italy, focusing on the data provided on the animal's health status, was performed through a five-year survey together with the number of organ and carcass condemnation for bovine, swine and ovine. The annual prevalence of condemnation was higher in bovine (from 10.49% in 2015 to 17.16% in 2019) than swine (from 6.39% in 2015 to 12.64% in 2019) and ovine (from 8.05% in 2019 to 8.98% in 2017), and an overall prevalence increase was observed in bovine and swine, throughout the years. The frequent lack of Food Chain Information (FCI) from farms to slaughterhouses should be emphasised, taking into consideration that a poor implementation of the system by farmers, could lead to a persistent risk of disease at farm level for these two species.

Introduction

The importance of zoonotic disease control and monitoring is highlighted by the occurrence, in recent decades, of several public health concerns stemmed from animals (King, 2004; de Melo *et al*., 2020). Studies of these episodes are attempted by the "One-health" multidisciplinary approach with the aim of removing or preventing "new and old" zoonoses that affect the health of humans, animals, and the ecosystem (Rabozzi *et al*., 2012). Meat inspection is a relevant practice to assure public health protection, animal health and welfare, as well as meat quality (EFSA, 2011). Meat control is mainly based on *ante-mortem* and *post-mortem* inspection, performed at the slaughterhouse by official Veterinarians, who generate a large amount of data useful to define trends in animal diseases, with particular emphasis on zoonotic ones, and their proper management and control at the farm level (Sánchez *et al*., 2018). Indeed, the World Organization for Animal Health (OIE) recognizes that slaughterhouses are key connections for the epidemiological monitoring of zoonoses and all animal diseases (OIE, 2019). In the last decade, a modernization process of meat control has been implemented in the European Union by an integrated system based on risk assessment, with feedback information among the main actors of the meat chain (EFSA, 2011; Korkeala, 2014). This approach was firstly declined by the White Paper on Food Safety of the Commission of the European Communities (2000) according to the principle "from farm to fork". It means that the policy of food safety must be based on a comprehensive and integrated approach, considering the entire food chain, including feed production, primary production, the environment, animal disease and welfare, food processing, storage, transport, and retail. An important role in this system is played by the Food Chain Information (FCI), which is provided by farmers to the competent authorities at slaughterhouse level and the Collection and Communication of Inspection Results (CCIR), which then goes from the slaughterhouse to the farm. The FCI provides information on the farm's official health status (including restrictions for public health reasons), drug administration to animals (no treatments in the last 90 days or respect of withdrawal time), occurrence of animal diseases (no sign of diseases), and results of previous meat inspection activities performed at slaughterhouse level. The CCIR provides information on relevant results observed at *ante-mortem* inspection, dealing with animal welfare, cleanliness, and health status (with pertinent analytical results), as well as relevant pathological findings at *post-mortem* inspection level and pertinent analytical results (Regulation (EC) No. 2074/2005). The relevance of the proper implementation of the system is highlighted in Regulation (EC) No. 853/2004 and recently in the Commission Implementing Regulation (EU) No. 627/2019 (transposed at national level by Legislative Decree No. 32/2021), where the obligations of the competent authorities and official veterinarians, as regards checks of FCI documents (art. 9 and 10) and measures concerning communication of the results of official controls (art. 39), are laid down. The correct implementation of the system could reduce *ante-mortem* and *post-mortem* findings and therefore public health risk, as it informs and sensitizes farmers to develop specific control systems and management strategies for the main diseases present in the herd. Furthermore, the proper management, as a result, could improve production systems leading to better animal health and welfare. Furthermore, the implementation of the FCI system, together with slaughterhouse implementation of food process hygiene criteria and the classification according to their capability to reduce faecal contamination, is a relevant part of the risk characterization in the food chain (EFSA, 2013). Several data are available in literature regarding the prevalence of the major causes of organs and carcass condemnations and the importance on the FCI feedback system, highlighting limitations and advantages of the system (Pattono *et al*., 2014; Felin *et al*., 2016; Gomes-Nieves *et al*., 2018; Guardone *et al*., 2020). The infor-

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mation is generally provided by industrial abattoirs with a high rate of slaughtering or that specialize in a single animal species (Ghidini *et al*., 2018; Sánchez *et al*., 2018; Laukkanen-Ninios *et al*. 2020). Few data are present on medium-small sized abattoirs specialized in slaughter animals from local farms (Guardone *et al*., 2020), where the effects of a proper implementation of the FCI system could have relevant, and easy to monitor, follow up on animal health status.

The aim of the paper is to report the organ and carcass condemnations trend, for the main three ungulates (bovine, swine, ovine) dedicated to meat production, in medium or small-sized slaughterhouses in central Italy. Furthermore, the relevance of the information provided by the FCI system in the examined slaughterhouses, focusing on the information provided on the animals' health status, was reported together with the possible direct or indirect implication on meat safety control.

Materials and methods

The number of one or more organs (partial) or of the whole carcass (total) condemned at *post-mortem* inspection for bovine, swine and ovine was obtained through a retrospective observational study conducted in 12 small or medium-sized slaughterhouses (from 900 to 8,000 bovine, from 4,000 to 50,000 swine, and from 1,000 to 5,000 ovine slaughtered annually). The abattoirs were located in three regions of central Italy (Figure 1) and were mainly specialized in the slaughter of locally farmed animal. The data were collected from January 2015 to December 2019 and provided by the official veterinarians in charge of the meat inspection and FCI control at slaughterhouse level. All inspections were conducted by official veterinarians. Uniform lesion codes were adopted between the slaughterhouses and referred to general inflammatory/degenerative lesions or specific diseases (Guardone *et al*., 2020). The FCI documents, at the arrival at slaughterhouse as well as CCRI, were also registered and considered, focusing on the animal health status.

Statistical analysis

Data were analyzed using R statistical software (Version 4.0.2, R Foundation for Statistical Computing). A logistic regression model was estimated to study the overtime trend of partial and total condemnations registered at slaughterhouse level and relevant species. The model was built considering two independent variables: years, modeled as numeric values from 1 to 5, and species, modeled as categorical variable with ovine as reference category. Interaction terms between years and species were also included. A $P<0.05$ was considered significant.

Results

The number of animals observed during the five-year period ranged from 20,219 (2015) to 22,500 (2018) bovines (considering veal, female, and male adults), from 114,833 (2015) to 117,864 (2018) swine (both light and heavy animals) and from 13,262 (2019) to 20,527 (2017) ovine (mainly lambs).

The numbers of partial and total condemnations were 2,905.6 for bovine (average prevalence 13.42%), 10,746.2 for swine (average prevalence 9.15%) and 1,413.4 for ovine (average prevalence 8,40%). The yearly recorded prevalence for the species is reported in Figure 2.

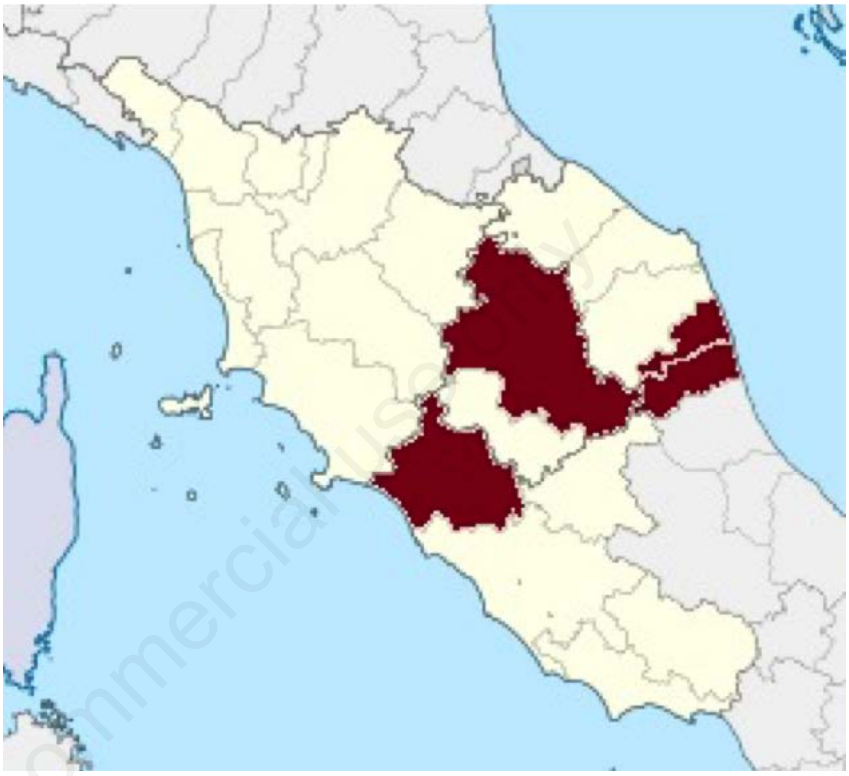

Figure 1. Provinces of central Italy where the involved slaughterhouses were located.

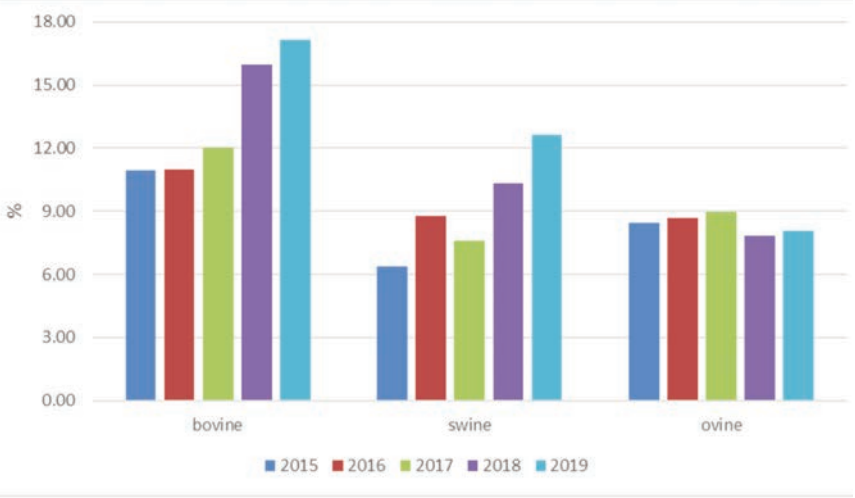

Figure 2. Observed prevalence (%) of partial and total condemnations registered at slaughterhouse level.

The logistic regression analysis shows that the prevalence on the log odds scale at year 2015 was negative for all species, denoting that all absolute prevalence values were smaller than 50%. On average, in the same year, bovine and ovine species did not differ significantly. Swine, which showed the smaller intercept, exhibited on average the highest increase per year. While bovine have shown a significantly positive trend over time, which was marginally lower than that of swine, ovine have shown a slightly negative one (Figure 3).

No information on the health status of animals at the farm level or any results of inspections at the slaughterhouse level was ever reported by farmers in the FCI reports submitted at the abattoirs.

The average number of CCIR information provided to farmers are reported in Table 1 and the prevalence of notifications by year regarding slaughtered animals is reported in Figure 4. The cause of CCIR in bovine was almost echinococcosis/hydatidosis (98%), while massive (when more than 50% of batch subjects were affected) parasitic infestation of the liver (75%), septicaemia (20%), *Erysipelothrix rhusiopathiae* infection (4%) were reported as the most frequent causes in swine. In ovine, all notifications were associated to parasitic lesions of lung and liver.

Furthermore, the amount and causes of all organ and carcass withdrawals were correctly notified to the owners of the carcasses, who, according to the Italian national legislation, often correspond to farmers at local level, (art. 17 of Royal Decree No. 3298/1928, repealed in March 2021 by national Legislative Decree No. 27/2021).

Discussion

The results show a higher partial or total condemnation rate in bovine, followed by swine and ovine. The considerable presence of pathological findings in bovine is reported by other authors and could be linked to the age of animals conducted to the slaughterhouse (Blanco-Penedo *et al*., 2012; Kaluza *et al*., 2021). The rearing systems adopted are not always related to the prevalence of pathological findings (Blanco-Penedo *et al*., 2012). Swine are intensively farmed, therefore they are more prone to conditioned pathologies (Hanson *et al*., 2001), while in central Italy ovine are slaughtered at a noticeably young age and generally reared in free range systems, therefore more susceptible to parasitic lesions. The average condemnation rates are similar to those reported by Vial *et al*. (2015) and Guardone *et al*., (2020) in bovine and swine, respectively. Data on lambs are generally related to specific pathologies or peculiar geographic areas and therefore not comparable to those recorded in the considered slaughterhouses (Ranucci and Serra, 2002; Teudoropulos *et al*., 2002; Mellau *et al*., 2013).

The cumulative prevalence of CCIR (Figure 4) was higher for bovine, followed by ovine and swine, but it must be considered that in the latter, notifications are generally performed on the batch and not on single animals.

Despite the hypothesis considered, the organ and carcass condemnations trend increased during the observed period in both bovine and swine. This result, together with the lack of FCI on animal health status provided to the slaughterhouse, reveals a poor implementation of the system by farmers and the persistency of disease risk at farm level for these two species. The persistence of echinococcosis/hydatidosis in bovine reported every year in the selected abattoirs is an example. Despite the lack of risk from food consumption, this disease is a relevant zoonotic issue worldwide

Table 1. Average number of Collection and Communication of Inspection Results notifications per year provided by official veterinarians to farmers.

	Annual average value
Bovine	36.2
Swine	8.2
Ovine	3.0

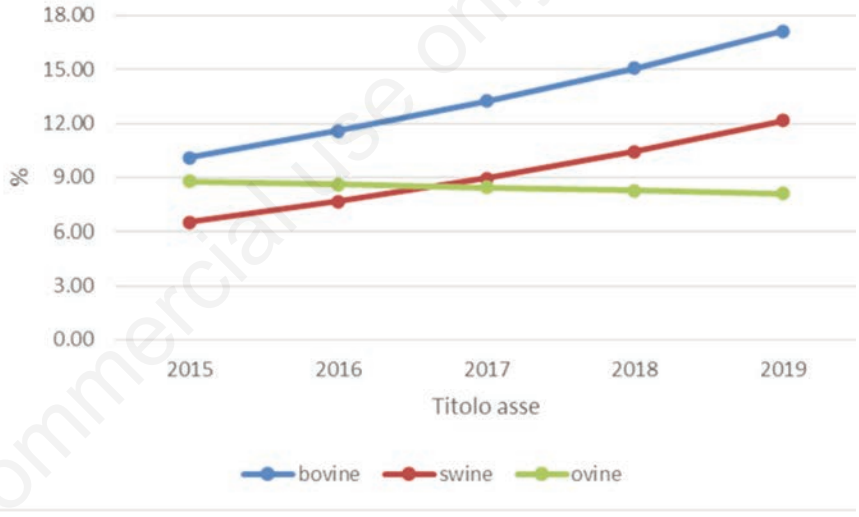

Figure 3. Fitted prevalence (%) of partial and total condemnations registered at slaughterhouse level.

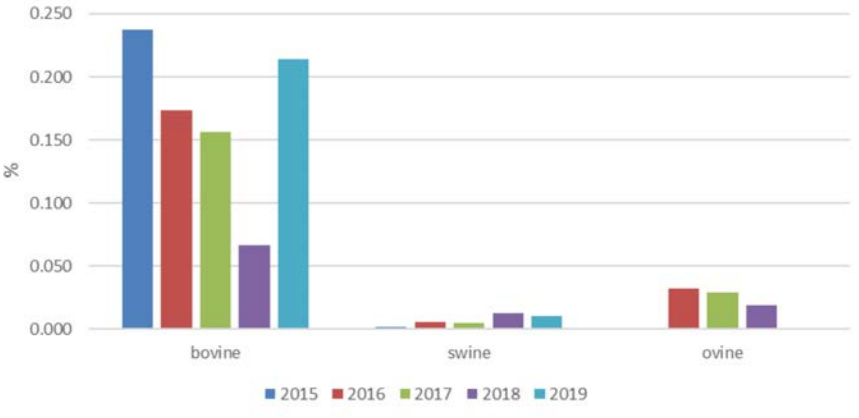

Figure 4. Prevalence (%) of Collection and Communication of Inspection Results on total slaughtered animals.

(Dakkar, 2010) and a proper management system should therefore be implemented to solve this problem at farm level. Another potential zoonosis is erysipelas, which is also reported in Italian abattoirs, in intensively farmed swine with a low prevalence of 0.01% and 0.30% by Guardone *et al*. (2020) and by Ghidini *et al*. (2018), respectively. *E. rhusiopathiae* is reported as a professional pathogen (Reboli and Farrar, 1989), nonetheless it is considered a negligible risk for foodborne health impact and human public health in general (Hill *et al*., 2014). No lesion caused by other zoonotic agents, such as *Mycobacterium* spp. or *Cysticercus bovis*, has been recorded.

A meaningful remark of the survey is that despite the presence of information submitted by the official veterinarians from the slaughterhouse (CCIR and art. 17 of Royal Decree No. 3298/1928), there is a lack of communication related to animal health status and results of *ante-mortem* and *post-mortem* inspections in the FCI. The incomplete formulation of FCI has been highlighted by other authors. In Portugal, Gomez-Nieves *et al*. (2018) refers to 28.9% of invalid reports on farm health status for pigs, and 92.1% and 99.2% of "nothing to declare" about the occurrence of diseases in bovine and sheep, respectively. Similar percentages are reported for *ante-mortem* and *post-mortem* inspection results with 100%, 99.0% and 99.6% of non-response, plus "nothing to declare" in bovine, pigs, and small ruminants, respectively. In a survey on bovine and swine slaughterhouses in the Piedmont Region (Italy), Pattono *et al*. (2014) classified the FCI as "negative" (not completed in almost one part of the module) and "absent" (not completed at all) reporting a range from 78.9% to 99.1% for the former and from 0.9% to 11.2% for the latter, highlighting a critical aspect of the communication system. A poor relevance of the information system is also reported (Felin *et al*., 2016), therefore confirming the results obtained in the present study on small-medium enterprises, mainly devoted to the slaughter of local animal. The farmers are probably not completely conscious of the benefit of the information system which could help them reduce the condemnation rate of carcasses and organs, lowering economic losses and waste treatment impact (Franke-Whittle and Insam, 2013; Yibar *et al*., 2015). Attention must be given also to other important information on farm management and risk factors for zoonotic diseases, that could be retrieved by organ or carcass condemnations. For example, the high level of parasitic lesions in swine could be a "warning" for the appropriate farm biosecurity management, which could favour the presence of pathogens responsible for relevant foodborne diseases, such as *Salmonella* spp. or *Toxoplasma gondii* (Ranucci *et al*., 2012; Andrews and Davies, 2015). Risk reduction measures, based on herd health programmes against these pathogens, are suggested by EFSA (2011) and therefore the food industry could benefit from the correct implementation of proper biosecurity plans at farm level. The lack of attention given to the informative system detected in this survey. also raises doubts regarding the effectiveness of further integrated approaches in these farms for the monitoring of major pathogens in the meat supply chain, such as Salmonella spp. (Primavilla *et al*., 2021), recently highlighted by EU legislation (Regulation (EU) No. 625/2017). The new approach suggested by EFSA, with the definition of Harmonized Epidemiological Indicators to be considered at farm, transport, and slaughterhouse level, could not be effective without a proper integration of the information between veterinarians at farm level and official veterinarians at abattoir. The use of advanced computer systems to support this information, could greatly facilitate the communication between these two levels of the meat chain.

Conclusions

The role of veterinarians in the epidemiological monitoring of zoonoses and foodborne diseases is crucial, and information provided by *ant-mortem* and *post-mortem* inspections is relevant to define direct and indirect animal and human disease control measures. There is evidence that communication between the farm and the abattoir is not completely efficient and effective, and the system needs to be properly implemented. Farmers should be trained on the importance of the information system and must carefully read the outcomes of slaughterhouse records, should not be viewed as products of an inevitable bureaucratic procedure. This information could be also a valuable index for the correct farming management and the implementation of relevant biosecurity strategies against major foodborne pathogens in meat chain. Only when a proper implementation of this system is performed, even in small size herds, a correct risk characterization of the farms could be carried out and a food safety chain approach could be achieved. In addition, a proper FCI description is of paramount importance to facilitate meat inspection activities at slaughterhouse level.

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