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Non-relevant *Salmonella* serotypes in fresh poultry meat: critical issues for official control officers at market level

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Abstract
European Union (EU) and Italian legislation provide extensive control measures for non-typhoidal (NTS) *Salmonella* along the poultry production chain; however, a regulatory gap persists for fresh poultry meat. Current EU microbiological criteria apply only to NTS serotypes of major public health significance ("relevant"), whereas the management of other NTS serotypes ("non-relevant") is not harmonized.
This study assessed the risk management strategies adopted by official veterinarians following the detection of non-relevant serotypes in fresh poultry meat at the distribution stage. Relevant EU and Italian legislation were analyzed, and operational practices in Italy were investigated through a structured questionnaire administered to local health units. In addition, EU-level approaches were examined through the analysis of Rapid Alert System for Food and Feed (RASFF) notifications.
The results revealed substantial heterogeneity in the management of comparable findings at both the national and EU levels, reflecting regulatory ambiguities and broad discretionary powers of competent authorities, thereby complicating the implementation of consistent and proportionate official controls. This variability is further challenged by the increasing epidemiological relevance of certain non-relevant serotypes, particularly *S.* Infantis. The study highlights the need for a revision and harmonization of the regulatory framework to support consistent and proportionate official control practices while ensuring a high level of consumer protection.

Introduction
Salmonella is a bacterium belonging to the *Enterobacteriaceae* family, of considerable public health importance (Rahman *et al*., 2018). The genus comprises over 2600 serotypes, many of which are pathogenic to humans and animals (Lamas *et al*., 2018; Naushad *et al*., 2023). In the context of human disease, *Salmonella* serotypes are generally classified as typhoidal and non-typhoidal (NTS) (Hiyoshi *et al*., 2018; Johnson *et al.*, 2018), also referred to as agents of major and minor salmonellosis (Popa and Papa, 2021). Typhoidal serotypes (*S.* Typhi and *S.* Paratyphi), highly adapted to humans, cause severe systemic infections (Buzilă *et al.*, 2025), whereas NTS serotypes are zoonotic agents and are mainly associated with gastrointestinal syndromes (EFSA, 2025).
Salmonella represents a major public health concern worldwide (Kumar *et al*., 2025). In 2024, 79,703 confirmed human cases were reported in the European Union (EU). Among cases with known serotypes, *S.* Enteritidis (58.4%), *S.* Typhimurium (11.0%), and its monophasic variant (antigenic formula 1,4[5],12:i) (10.4%) were the most frequently identified (EFSA, ECDC, 2025). However, fatalities were also associated with other serotypes, including *S.* Infantis (n=4) and *S.* Derby (n=1) (ECDC, 2025). Poultry remains a major source of infection, accounting for more than 100 of the 247 strong evidence outbreaks reported in the EU (EFSA, ECDC, 2025).
At the EU level, *Salmonella* is among the pathogens subject to mandatory surveillance under EU zoonosis control legislation (European Parliament and Council of the European Union, 2003a). Regulation (EC) No 2160/2003, mainly focused on primary production, and implemented through the related National Salmonellosis Control Plans (NSCP), aims to reduce the prevalence of NTS serotypes of major public health significance, hereinafter referred to as "relevant" (European Parliament and Council of the European Union, 2003b). In addition, safety requirements applicable to poultry meat and products are primarily defined by Regulation (EC) No 2073/2005 (European Commission, 2005a). Over time, additional national operational guidance documents (ministerial notes) have been introduced in Italy to support the management of "non-relevant" *Salmonella* serotypes (all other NTS serotypes) in fresh poultry meat. The most recent one (2022), although explicitly described as an interlocutory, non-binding act (Ministry of Health, 2022a), introduced more stringent requirements than previous guidance, thereby creating uncertainty in its practical implementation. Therefore, risk management remains heterogeneous and insufficiently standardized across control systems, despite their increasing prevalence and potential public health implications.

This study aims to assess the risk management strategies adopted by official veterinarians (OVs) when non-relevant serotypes are detected in fresh poultry meat at the distribution stage, and to evaluate the consistency of official controls in a regulatory context lacking specific harmonized criteria. To this end, a collection and analysis of the relevant EU and Italian legislation concerning *Salmonella* control along the poultry chain was performed. Then, a survey was conducted through the administration of a questionnaire to Italian Local Health Units (LHUs) to investigate the legal basis adopted in response to the detection of non-relevant serotypes. The survey results were complemented by the collection of the corresponding data related to Rapid Alert System for Food and Feed (RASFF) notifications, thereby providing a broader European perspective on current risk management practices.

Materials and Methods

Collection and analysis of legislation

Relevant EU and Italian legislation concerning *Salmonella* control along the poultry chain was collected and reviewed to support the interpretation of local and EU control procedures adopted by OVs.

Questionnaire administration to Italian competent authorities and European Union Rapid Alert System for Food and Feed notifications analysis

A structured questionnaire with predefined fields was distributed to Italian LHUs to collect data on official controls carried out on fresh poultry meat at the distribution stage during the period 2021-2023. One LHU per Italian region was contacted on a pragmatic, non-random basis, with the aim of ensuring broad geographical coverage of the national territory. Participation was voluntary, and a total of 12 LHUs returned complete responses. Respondents were asked to report the total number of official samples of fresh poultry meat collected for *Salmonella* testing, the number of positive samples, and the identified serotypes. The questionnaire also included a descriptive section aimed at collecting information on the legal basis adopted and the measures implemented by the competent authorities (CAs) following the detection of non-relevant serotypes. Data were collected and analyzed at an aggregated level, without reference to individual LHUs. The questionnaire was designed for descriptive purposes and was not intended to support statistical inference. In parallel, for the year 2023, information on the management at the EU level of findings of non-relevant serotypes in fresh poultry meat was collected by consulting the RASFF Window and i-RASFF platforms. The RASFF notifications were analyzed descriptively to identify the legal basis cited and the risk management measures adopted by CAs, rather than performing a quantitative or statistical assessment.

Results and Discussion

Analysis of the European Union and Italian legislation

The management of *Salmonella* along the poultry production chain is governed by a comprehensive set of European and national rules that establish monitoring and surveillance obligations, microbiological criteria, and the respective responsibilities of CAs and food business operators (FBOs) (*Supplementary Table 1;* European Commission, 2010; European Commission, 2012a; European Commission, 2012b). For this study, only the core regulatory instruments directly influencing official control activities were examined.

At the EU level, *Salmonella* is subject to mandatory surveillance under Directive 2003/99/EC on zoonoses monitoring. Specific rules for the control of *Salmonella* in poultry are laid down in Regulation (EC) No 2160/2003 and its implementing measures, which focus on the primary production stage. This regulation provides for the establishment of EU reduction targets for serotypes of major public health significance, which are identified based on the criteria set out in Annex III. Accordingly, the list of relevant serotypes varies according to the poultry sector: in poultry meat

production, these are *S.* Enteritidis and *S.* Typhimurium (including its monophasic variant), whereas in breeding flocks of *Gallus gallus* the list also includes *S.* Infantis, *S.* Hadar, and *S.* Virchow. To achieve the EU targets, Member States must adopt national control programmes, such as the Italian NSCP 2025-2027 (Ministry of Health, 2025) (Figure 1).

In addition, the microbiological criteria applicable to poultry products are defined in Regulation (EC) No 2073/2005. For fresh poultry meat, only the two relevant serotypes (*S.* Enteritidis and *S.* Typhimurium, monophasic variant included) constitute a food safety criterion. In contrast, for other meat categories, such as minced meat, meat preparations, and mechanically separated meat, the regulation requires the complete absence of *Salmonella* spp., thereby also encompassing non-relevant serotypes. This regulatory asymmetry leaves the management of non-relevant serotypes in fresh poultry meat insufficiently defined.

In the absence of specific microbiological criteria, CAs must rely on cross-cutting provisions such as Regulation (EC) No 178/2002 (European Parliament and Council of the European Union, 2002), which establishes the general principles of food safety and outlines the circumstances under which food should be deemed unsafe. Furthermore, Regulation (EU) 2017/625 grants CAs the discretion to impose corrective measures proportionate to the risk identified (European Parliament and Council of the European Union, 2017), even where no explicit microbiological standard exists. Consistently, the Court of Justice of the EU clarified in the *Romega* case (Court of Justice, 2022) that the CA, pursuant to Article 1 of Regulation (EC) No 2073/2005 in conjunction with Article 14 of Regulation (EC) No 178/2002 "may regard as unsafe the food category consisting in fresh poultry meat in which pathogenic microorganisms other than the Salmonella serotypes listed in point 1.28 of Chapter 1 of Annex I to Regulation No 2073/2005 have been detected".

In addition, at the Italian level, the Ministry of Health has issued several ministerial notes concerning the management of fresh poultry meat found to be contaminated with non-relevant serotypes. Particularly, DGISAN Notes No 0030530/2015 and No 0001038/2016 stated that withdrawal or recall is not required when labelling ensures consumer protection by specifying the intended use (thorough cooking at least 75°C at the core) (Ministry of Health, 2015, 2016). However, the subsequent DGISAN Note No 0004901/2022 has provoked uncertainty among Cas, as it sets, for non-relevant serotypes, the same requirements as those provided for the relevant ones (Ministry of Health, 2022b).

Overall, while the regulatory framework is well defined for relevant serotypes, it remains considerably less prescriptive for non-relevant ones. This structural ambiguity creates conditions for heterogeneous risk management approaches; an issue that clearly emerged from the responses gathered through the questionnaire and from the analysis of RASFF notifications, which are further explored in the following sections.

Questionnaire and European Union Rapid Alert System for Food and Feed notifications: analysis of results in the context of the regulatory framework

A total of 12 questionnaires from LHUs were analyzed, covering 332 official samples of fresh poultry meat collected at the distribution stage. Among these, 50 samples (15.1%) were positive for *Salmonella*. Only 7 isolates (14%) corresponded to serotypes classified as relevant under current EU legislation, all identified as *S.* Enteritidis, while the remaining 43 isolates (86%) consisted of non-relevant serotypes, with *S.* Infantis representing the great majority (76.7%). This result is consistent with the current epidemiological scenario, in which *S.* Infantis is recognized as an emerging multidrug-resistant serotype capable of persistence along the food chain through enhanced biofilm formation (Mattock *et al.*, 2024; Krüger *et al.*, 2025). This epidemiological evolution further challenges the current dichotomy between relevant and non-relevant serotypes established in Regulation (EC) No 2160/2003.

The analysis of the action taken by CAs following the detection of non-relevant serotypes revealed a considerable heterogeneity, reflecting the fragmented regulatory context outlined in the section

Analysis of the European Union and Italian legislation. All respondents reported notifying the positive finding to the CA territorially responsible for the production establishment, to intensify official controls. This practice is grounded in the enforcement obligations under Regulation (EU) No 2017/625 (Art. 138, investigation and determination of the origin and extent of the non-compliance) and is consistent with the framework for communicating official control results laid down in Regulation (EU) No 2019/627 (Art. 39) (European Commission, 2019). Finally, this information flow is aligned with the approach of the national guidance on Regulation (EC) No 2073/2005 which, although referring to the slaughterhouse context, outlines an upstream notification mechanism that can reasonably be extended, by analogy, to the subsequent stages of the food chain (41/CSR-2016) (CSR, 2016).

Beyond this common approach, however, significant differences emerged. A large majority of CAs (92%) addressed non-relevant *Salmonella* findings by verifying compliance with Article 14 of Regulation (EC) No 178/2002, specifically assessing the presence of clear instructions requiring thorough cooking (at least 75°C at the core). When such instructions were correctly displayed, LHUs considered the product safe for its intended use, consistent with the interpretations provided by DGISAN Notes No 0030530/2015 and No 0001038/2016. In contrast, approximately 17% of the respondents adopted a more restrictive interpretation, deeming non-relevant serotypes in fresh poultry meat a potential health risk, citing Law 283/1962 (Art. 5, letter d) (Italian Republic, 1962); following the transmission of criminal reports to the Judicial Authority, some proceedings were archived. Finally, an even smaller proportion of respondents (8%) adopted the most precautionary measure available by activating the RASFF system, treating the detection of non-relevant serotypes as a serious risk under Article 19 of Regulation (EC) No 178/2002.

Overall, the survey reveals a pronounced variability in how Italian LHUs manage non-relevant *Salmonella* serotypes in fresh poultry meat. It is particularly noteworthy that such heterogeneity already emerges in a limited sample of 12 LHUs, making even greater variability plausible if all CAs were considered. This heterogeneity may arise from the coexistence of non-binding and sometimes inconsistent national guidance, and the broad discretionary powers conferred upon CAs by EU legislation. Furthermore, we cannot fail to consider that the microbiological criterion limited to *Salmonella* Enteritidis and *Salmonella* Typhimurium in the fresh poultry meat, introduced by Regulation (EU) No 1086/2011 (European Commission, 2011), that amended Regulation (EC) No 2073/2005, was defined by considering the "*best balance between reducing human salmonellosis attributed to the consumption of poultry meat and the economic consequences of the application of that criterion*".

Also at EU level, CAs assess and manage the risk in a non-uniform manner, reflecting regulatory and operational uncertainty due to the lack of a harmonized regulatory context for these serotypes. However, it should be noted that the analysis of notifications was affected by intrinsic limitations of the RASFF dataset, such as data entry errors and missing or incomplete fields (Pigłowski, 2025), which inevitably limited the interpretation of the results. Based on the available data collected, most EU CAs activated the RASFF by referring to Regulation (EC) No 178/2002. A substantial proportion of notifications also cited Regulation (EC) No 2073/2005, despite the absence of a specific food safety criterion for non-relevant serotypes in fresh poultry meat, likely relying on a combined reading with Article 14 (paragraph 8) of Regulation (EC) No 178/2002. Only sporadically were Regulation (EC) No 1688/2005 (European Commission, 2005b) or Regulation (EC) No 178/2002 in conjunction with Regulation (EC) No 1069/2009 cited (European Parliament and Council of the European Union, 2009). As for the actions taken, they were similarly heterogeneous, including increased frequency of official controls, notification of other CAs involved, and requests for withdrawal and recall of products from the market, as well as product blocking, meat heat treatment, or destruction.

Conclusions

Pursuant to Article 1 of Regulation (EC) No 2073/2005, in conjunction with Article 14(8) of Regulation (EC) No 178/2002, CAs may adopt specific risk management measures under Article 138 of Regulation (EU) No 2017/625 to protect consumers from potential risks associated with the presence of non-relevant serotypes in fresh poultry meat. This discretionary power is further supported by the 2022 judgment of the Court of Justice of the European Union (C-89/21, 28 April 2022). However, the absence of microbiological criteria for non-relevant serotypes in fresh poultry meat contributes to substantial variability in the assessment and management of similar non-compliances, both at the national and EU levels. As shown by the results of this study, comparable findings may lead to different enforcement measures depending on the CA involved. Such heterogeneity does not stem from a lack of legal basis, but rather from structural regulatory gaps that affect the consistency and predictability of official control activities and may result in unequal treatment of FBOs across different jurisdictions. In light of the increasing epidemiological relevance of certain non-relevant serotypes, such as *S.* Infantis, and their growing antimicrobial resistance, a revision and harmonization of EU and national regulatory frameworks, based on updated risk assessment, would support more consistent and proportionate risk management practices while maintaining a high level of consumer protection.

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Online supplementary material

Supplementary Table 1. European Union and national legislative references and operational guidance documents on *Salmonella* in the poultry chain.

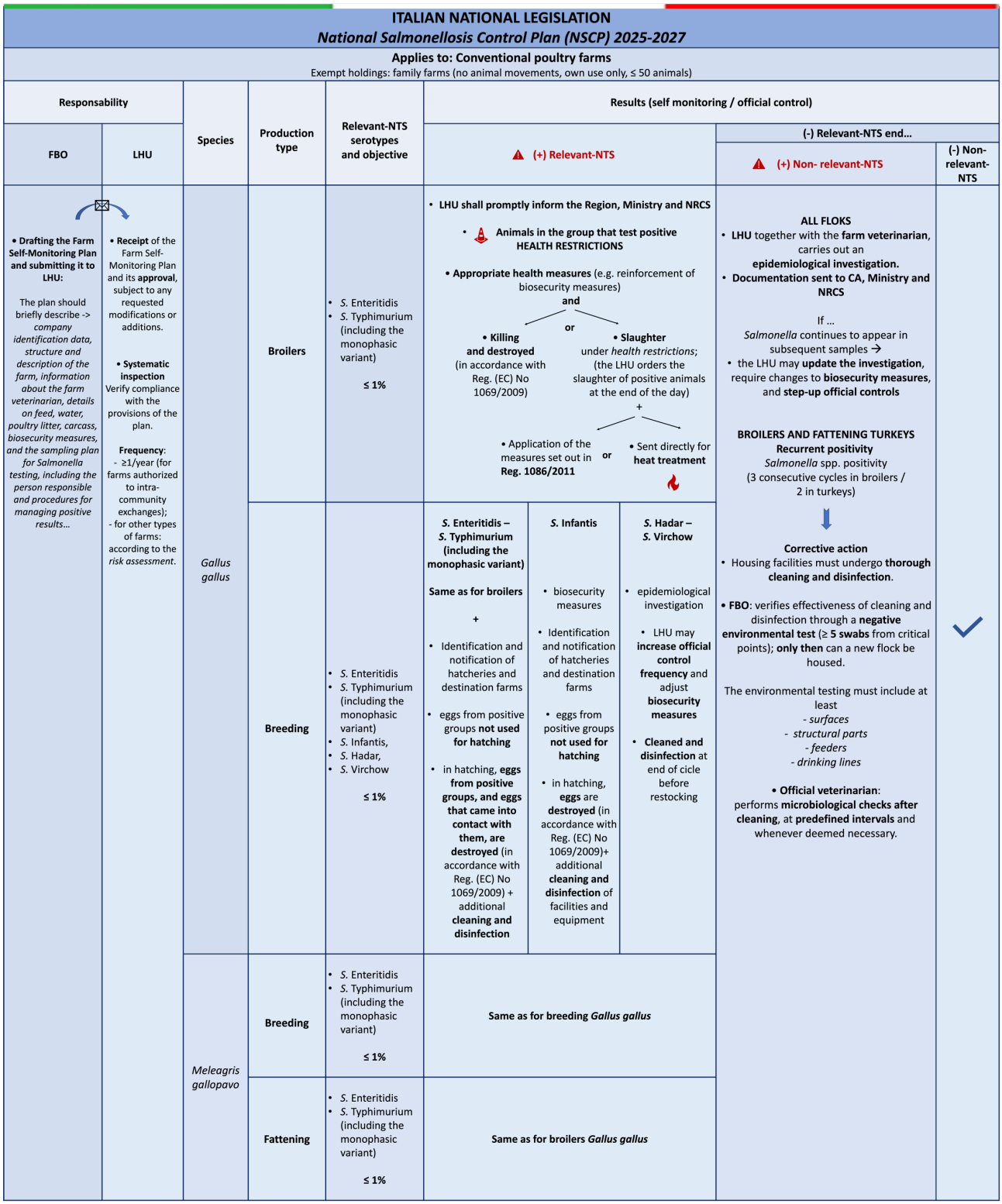

Figure 1. National Salmonellosis Control Plan (NSCP) 2025-2027. FBO, food business operator; LHU, local health unit; NTS, non-typhoidal *Salmonella*; NRCS, National Reference Center for Salmonellosis, CA, competent authority.