European benchmarks for AI-based detection of broiler carcass lesions and insights from official veterinarians on broiler post-mortem inspection

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Summary

The study developed European benchmarks for AI-assisted detection of broiler carcass lesions and explored factors influencing official veterinarians' (OVs) post-mortem inspection (PMI) decisions. Using an online survey across 14 countries, researchers defined severity-based cutoff points for six lesions to support validation of the VetInspector computer-vision system (CVS). Responses revealed variability in inspection practices, communication, training, and decision-making, highlighting the need for clearer guidelines and technological support. Harmonised PMI criteria and CVS implementation could improve inspection consistency, manage high line speeds, and enhance welfare and food-safety monitoring.

Introduction

Official meat control in the European Union (EU) consists of ante-mortem inspection (AMI) and PMI [1]. Currently PMI in broilers is based on a visual assessment of carcasses and accompanying organs, usually performed by OVs, official auxiliaries or abattoirs staff working under supervision of the OV. In the modern slaughter lines, the high line speed implies that the four broiler carcasses are supposed to be inspected per second. In the future, an expected even higher slaughter speed challenges the quality of the meat inspection.

Implementation of CVSs, like VetInspector, could solve this concern. In the EU, CVSs were allowed to be used as assisting tools in poultry PMI. The VetInspector system includes four camera stations: footpad dermatitis scoring, external surface assessment before evisceration, evaluation of internal organs, and verification of carcass hygiene after evisceration. Adoption of a CVS tool would allow for a higher quality of the PMI as well as more precise and detailed data collection and analysis. Additionally, several findings could be registered for individual broilers, enabling the setting of more accurate diagnoses for affected flocks. This could result in a more targeted disease prevention and faster welfare issues detection at farm level. However, before being adopted, a standardisation of the PMI procedures is required. First, it is necessary to harmonise the codes corresponding to the findings detected in the PMI for broilers in Europe. Next, we need to agree on the severity criteria used for each of the codes. This could be agreed on at a national or EU level, the latter allowing higher transparency among trade partners.

The aim of this study was to develop an AI model test dataset (benchmark) for the six codes used in PMI of broiler before evisceration of the carcasses and to determine the factors influencing the decisions made by OVs when performing duties related to PMI of broilers.

Methods

An online questionnaire to gather information on how European OVs currently perform PMI of broiler carcasses was created in SurveyXact (https://rambollxact.com/surveyxact). The survey was available in multiple European languages. The survey participants were OVs working daily in broiler abattoirs and recruited through national competent authorities (CA). Countries included in the study (Denmark, France, Germany, Greece, Italy, Latvia, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, and the United Kingdom) covered all regions of Europe. Data were collected between 1 October and 1 December 2025. Participation was voluntary and anonymous. Due to guaranteed anonymity, cross-country comparisons were not aimed for.

In the first section of the survey, participants were asked to determine the threshold at which a carcass should be considered unfit for human consumption based on photos showing increasing lesion severity on external carcass surfaces. The assessed lesions included emaciation, dermatitis, ascites, bruising, processing-related damage, and hock burn. Each lesion was presented with pictures representing the subsequent degrees of severity, from complete absence of anomaly (severity level 1), through mild (2), moderate (3-4), severe (5-6) and extremely severe (7).

The responses were presented in terms of cumulative severity levels. For example, selecting level 3 meant that all higher levels (4 to 7) were also considered unfit. Using these responses together with the accompanying risk assessment, we established evaluation benchmarks for each lesion type. The cutoff point was defined as the severity level at which most respondents, representing two-thirds (66.7 ± 1%), classified the carcass as unfit for human consumption.

In the second part, the OVs' perceptions, training, daily tasks, communication, and factors influencing their PMI decisions were explored. The questionnaire aimed to identify what shapes OVs' decisions during broiler PMI and how training, guidelines, and personal perceptions contribute to these assessments. The analysis of responses followed a modified and simplified protocol for practical thematic analysis. The analysis was conducted by six team members with experience in veterinary epidemiology, poultry pathology, and meat inspection.

Results

A total of 155 respondents participated in the survey. Responses were recorded after each question, so partial data from incomplete surveys were also included in the analysis. Among all respondents, 119 (76.8%) completed all quantitative questions, and 69 (44.5%) took part in the second section containing open-ended questions. Median experience of the respondents in PMI of broilers was 5 years.

Table 1 presents severity-level benchmarks for external broiler carcass lesions based on when at least two-thirds (>66.7%±1%) of veterinarians judged a carcass unfit. Most respondents assigned severity levels that clearly indicated pathological change visible in the picture presenting the lesion. This included choosing level "5" for emaciation, hock burn, bruises, and wooden breast. For ascites and dermatitis/cellulitis, respondents tended to rate lesions more severely, selecting level "4" more frequently, while for superficial dermatitis they more often chose level "3". Surprisingly, respondents were the most strict regarding muscle damage during post-slaughter processing of meat, indicating even minor damage (level "2") as a reason for considering the carcass unfit.

Open-ended questions section
The simplified thematic analysis process resulted in the identification of five themes, which are described in detail below.

Abattoir capacity and OV work hours
The 69 respondents who answered the open-ended questions in the second part of the survey consisted of OVs performing inspection in a wide range of abattoirs, from small-capacity plants to large-scale enterprises slaughtering up to 370,000 birds during a single working day. An identical proportion of OVs worked full-time and part-time in abattoirs (43% each). Among those working part-time in smaller facilities, most contributed only a few hours per week (28%), while a smaller group worked several dozen hours weekly (16%). The remaining respondents either did not report their working hours (10%) or were not currently employed in a slaughterhouse (4%).

Decision making and operational practices in broiler post-mortem inspection
The PMI of broilers is mainly a visual assessment of carcasses and organs, with palpation or cutting used only when necessary, and additional necropsy is performed by OVs for doubtful cases. Although the OVs can inspect

all carcasses, the PMI is usually carried out by an OA or abattoir staff under the OVs' supervision, with OVs verifying only a portion of each flock. The PMI station setup varied because EU regulations do not define a precise PMI location, and on many abattoirs early inspection point to detect lesions was located before evisceration. Decisions on carcass fitness relied on national guidelines based on the EU law, though clarity varied, and inspectors often based their decision on lesion type, its severity, presence of contamination, and overall flock condition. In borderline cases, respondents frequently prioritized public health protection by condemning carcasses whenever potential risk could not be excluded.

Communication of inspection findings to stakeholders
Communication of PMI results varied widely and depended on national rules and inspection procedures. The OVs used official channels such as certified paper documents or approved electronic systems, but they often also relied on informal methods, including regular email, phone calls, online communicators, and in-person discussions with abattoir representatives to address issues promptly. PMI findings were usually communicated to the Food Business Operator (FBO) and, indirectly, to the poultry producer. Some OVs occasionally reached out to the flock veterinarian. Several respondents also routinely reported to the CA departments, and serious issues triggered immediate notification. One respondent noted that OVs had limited interaction with the stakeholders, except the transport companies, which often participated in operational meetings and were informed immediately when non-compliance occurred.

Training and support needs for performing PMI
Respondents stated that veterinary studies gave them a solid basis, which was supplemented by additional theoretical and practical training (a few days to several months), provided by the CA at the start of their employment. Ongoing mentoring, self-directed learning, and optional courses were also important. Some OVs received regular training through courses organized by the CA or relevant ministry, delivered in person or online, while others reported irregular training and a clear need for further education, especially in food safety, broiler welfare, and broiler health.

Most respondents felt adequately supported in performing PMI, citing access to training, modern equipment, and good collaboration with colleagues, authorities, and the FBO. Others, however, reported limited support and relied mainly on personal experience and guidance from senior colleagues. Several OVs described challenging working conditions, including insufficient space and inconsistent inspection standards across abattoirs. They emphasized the need for updated practical PMI guidelines with clear visual examples, more opportunities to exchange experiences with OVs from other plants, and greater use of technologies such as AI-supported CVS and automated data collection. Respondents also called for regular training and better access to official laboratories. Despite these concerns, most OVs still considered the existing support sufficient.

Impact on public health and consistency of inspection decisions
Respondents emphasized that PMI played a key role in public health by preventing the entry of meat from sick animals, carcasses with residues of antimicrobials, or those produced under poor hygiene, and highlighted the importance of food chain information, AMI, and PMI in safeguarding food safety. They also recognized the strong link between PMI findings and broiler welfare, noting that many causes of condemnation reflected poor on-farm conditions and that welfare assessments extend across transport, handling, stunning, and slaughter. While actions were sometimes taken when welfare-related non-compliances occurred, respondents felt that the consequences for the broiler producers were often limited and that stronger incentives for improvement were needed. Although the EU rules require only healthy birds to be sent to slaughter, OVs noted that PMI still provided insight into flock health, biosecurity, and the effectiveness of modern poultry production, which had reduced many historical diseases. Respondents stressed that consistent inspection decisions were essential, supported by clear guidelines, training, and communication among inspectors, although uniformity can be affected by factors such as line speed, lighting, fatigue, motivation, and variable interpretation when guidelines are lacking.

Discussion

Currently, there is no standardized European guideline of PMI for broilers that specifies which lesions to register and associated severity criteria for the individual lesions. To harmonize PMI in EU and to support VetInspector implementation, a risk-based condemnation code set, consisting of 13 findings related to broiler welfare, health and food safety has been developed [2]. Based on the OVs' responses, an attempt was made to establish risk-based condemnation criteria for six lesions detected in broiler carcasses. In the case of bruises, wooden breast and hock burn, most respondents decided that the carcass shown in photo number "5" should be considered unfit, which corresponds to an advanced degree of severity. Given that these anomalies typically do not impact food safety, carcasses with barely noticeable symptoms should not be rejected [3]. A similar issue occurred with emaciation/generalized disease, where diagnosis is difficult due to the varied causes of these findings.

Emaciation alone may present only as smaller, thin carcasses that can still be approved for consumption, whereas disease-related cases may also show altered skin color or meat texture, which must be considered when assessing fitness. Surprisingly, many respondents were highly restrictive toward processing related skin and muscle defects that do not affect food safety or animal welfare. Even minor muscle damage (photo number "2") was judged as reason for condemnation by a notable share of respondents. In the case of skin diseases and ascites, respondents showed a much more restrictive approach to the condemnation of carcasses with moderate lesions. Ascites is a major cause of carcass condemnation in abattoirs and impairs broiler welfare [4].

Respondents received guidance on the scoring procedure at the beginning of the survey. However, some seemed to have slightly misunderstood the instructions, since a few selected photo number "1," which showed a completely normal carcass, as unfit for human consumption. Also a small number of respondents indicated some of the lesions as insignificant in the PMI of broilers.

Data from the open-ended questions clearly showed that most OVs were well trained to perform and supervise broiler meat inspection. At the same time, some respondents highlighted differences in the way PMI is carried out between different inspectors, especially working in different abattoirs. The decision regarding meat fitness, particularly in borderline cases, depended mainly on the inspector's experience, the public health relevance of the finding, and the overall condition of the flock, all of which may influence the final judgement.

One of the needs the respondents reported was the introduction of new technologies, in particular camera-based systems, to improve PMI, make it more sustainable and to ensure the repeatability of decisions between different meat inspectors and abattoirs. A similar but larger dataset could be used to test that the CVS is continuously working.

Conclusion

Harmonizing broiler PMI codes and defining benchmarks would allow proper validation of the VetInspector CVS. VetInspector can manage high slaughter speeds, reducing capacity limitations of manual PMI without compromising inspection quality and could provide unbiased, bird-level inspection across abattoirs. In this study, benchmarks were developed for codes detected by the VetInspector external station. The next steps include creating benchmarks for the remaining stations, covering meat hygiene, footpad dermatitis and visceral lesions.

Lesion	Camera view	Severity level (cumulative % of respondents)							
		NA	1	2	3	4	5	6	7
Emaciation/generalized disease	Front	0	3.2	9.0	21.3	45.2	79.4	94.8	100
Dermatitis	Front	0	10.5	50.0	66.4	80.9	87.5	97.4	100
	Top	2.0	10.7	32.9	56.4	79.9	89.9	93.3	98.0
Superficial dermatitis	Front	6.1	4.7	37.2	66.2	74.3	84.5	87.2	93.9
Ascites	Front	0.7	4.1	19.0	45.6	70.7	84.4	91.8	99.3
Bruises on breast muscle	Front	1.4	0.7	5.4	20.4	45.6	88.4	95.9	98.6
Bruises on legs	Front	4.9	2.1	7.6	19.4	34.7	87.5	93.1	95.1
Wooden breast	Front	8.4	2.1	11.9	24.5	49.7	80.4	88.8	91.6
Processing related skin defects	Front	1.4	2.8	12.6	36.4	75.5	85.3	95.8	98.6
Processing related muscle defects	Front	0.7	7.0	68.5	76.9	87.4	97.9	98.6	99.3
Hock burn	Back	9.2	2.1	5.6	13.4	42.3	70.4	81.0	90.8

Table 1. Benchmarks for the lesions to external surfaces of broiler carcasses based on respondent-indicated threshold points, using 66.7±1% as the indication of the agreed threshold

Keywords: meat inspection, official veterinarian, computer vision system, broiler.

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