A path towards modernisation of meat safety assurance in European abattoirs

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Abstract. Carcass meat safety mainly relies on official meat inspection and abattoir process hygiene. The deficiencies of the traditional meat safety system are well known. The European Food Safety Authority has proposed a modern, risk-based meat safety assurance system. The process of implementation of the new system in Europe is in the initial phase and is associated with legislation changes. Several challenges are experienced in the implementation process so far and future challenges are anticipated. Further modernisation of the meat safety assurance system and its full practical implementation need to go in tandem with intensive research and training.

1. Background
Meat safety at the abattoir level of the meat chain is essentially and traditionally assured through official veterinary meat inspection and abattoir process hygiene. Veterinary meat inspection targets hazards that cause clinical signs and/or detectable lesions in animals at slaughter and gave an invaluable contribution to public health protection from zoonoses through the last century. However, it suffers from many flaws – the main one is that it is not risk-based and does not guarantee public health protection in regard to the most frequent meat-borne diseases today [1]. Abattoir process hygiene relies on prerequisite programmes and HACCP-based procedures and primarily aims to prevent faecal contamination of carcass meat associated with hazards that can only be detected through laboratory analyses. Therefore, abattoir process hygiene and meat inspection are complemented by laboratory testing, which also has many drawbacks including delayed results, non-proactiveness, relatedness only to the hazard examined, expensiveness and limited tests’ sensitivities and specificities [2].

The deficiencies of the traditional meat safety system are well known for decades. There is a trend in the European Union (EU) and developed countries worldwide to accomplish meat safety goals with a new, comprehensive concept that considers the occurrence of each hazard in the whole meat chain as a function of the hazard’s consequences for public health. The EU General Food Law [3] introduced an integrative farm-to-fork approach to food safety and application of the principles of risk analysis. The resultant “hygiene package” of legislation supported a risk-based approach to meat safety, primarily through Regulation 854/2004 [4]. A decade ago, the European Commission triggered scientific work to support the risk- and food chain-approach to meat safety assurance by delegating the European Food Safety Authority (EFSA) to prioritise biological and chemical public health hazards and recommend the new system of meat inspection and meat safety assurance.
2. State of the art

The EFSA’s opinions on hazards to be covered by meat inspection [5-10] pose the basis of risk-based meat safety assurance in Europe. The opinions primarily deal with the priority public health hazards, but also with animal health and welfare issues of the new, changed meat inspection practices. The EFSA ranked biological hazards mainly on the basis of incidence and severity of human disease and the strength of evidence that meat from respective animal species is an important risk factor for disease in humans. For chemical hazards, risk ranking was conducted based on the results of the national residue control plans and other specific parameters such as the toxicological profile and the likelihood of the occurrence of residues/contaminants in each animal species. Table 1 shows current priority (increased risk) hazards that originate from slaughtered animals and significantly affect carcass meat safety [5-10].

Table 1. Prioritised meat-borne hazards [5-10]

| Species          | Biological hazards              | Chemical hazards |
|------------------|---------------------------------|------------------|
| Pigs             | *Salmonella enterica*           | dioxins          |
|                  | *Yersinia enterocolitica*       | dioxin-like polychlorinated biphenyls |
|                  | *Toxoplasma gondii*             | chloramphenicol  |
|                  | *Trichinella spp.*              |                  |
| Poultry          | *Campylobacter spp.*            | dioxins          |
|                  | *Salmonella enterica*           | dioxin-like polychlorinated biphenyls |
|                  | ESBL-AmpC gene-carrying bacteria| chloramphenicol  |
|                  |                                 | nitrofurans      |
|                  |                                 | nitroimidazoles  |
| Cattle           | pathogenic *Escherichia coli*   | dioxins          |
|                  | *Salmonella enterica*           | dioxin-like polychlorinated biphenyls |
| Sheep and goats  | pathogenic *Escherichia coli*   | dioxins          |
|                  | *Toxoplasma gondii*             | dioxin-like polychlorinated biphenyls |
| Horses           | *Trichinella spp.*              | phenylbutazone   |
|                  |                                 | cadmium          |
| Farmed game      | deer *Toxoplasma gondii*        | none             |
|                  | wild boar *Salmonella enterica* | none             |
|                  | other *Toxoplasma gondii*       | none             |

The generic framework of the new meat safety assurance system is presented in Figure 1. The system is supposed to be risk-based, longitudinally integrated and focused on safety of chilled carcasses in abattoirs, primarily in regard to the priority hazards (Table 1). The meat safety levels (targets) of priority hazards in chilled carcasses are intended to be set through appropriate level of protection and related food safety objectives. The targets will be accomplished by the risk manager who will adjust control options in the meat chain, e.g. by the Food Chain Information (FCI) analyses and balance between farms and abattoirs based on their risk categorisations, by setting the intensity of meat inspection procedures (i.e. visual-only inspection of low-risk animals, or more stringent inspection procedures for high-risk animals) and by decision on additional carcass treatments in the case of high risk farms and/or abattoirs.
The legislation changes are a cornerstone of practical implementation of the new system and several changes have already been adopted in the EU legislation. These include process hygiene criteria for *Salmonella* on pork carcases that became more stringent in 2014 [11] and a visual-only inspection of slaughtered pigs that are considered to pose low risk [12]. Exemptions of *Trichinella* testing of pigs originating from farms with high biosecurity level as well as when their meat undergoes specific freezing treatment are regulated [13]. Also, process hygiene criteria for *Campylobacter* in broiler carcasses have recently been introduced [14]. The new legislation on official controls [15] will ensure, among other things, the application of food law and rules on animal health and welfare; finally, revised meat inspection procedures for all species [16] apply as of 14th December 2019.

For the relatively short period of initial implementation of the new concept in practice, several challenges are seen. For instance, amendment of the “old” pig meat inspection [4] with the “new” one [12] came into force in 2014 immediately in all EU Member States (MSs); however, the practical implementation of visual-only inspection of pigs is seen only in a few MSs so far. The main reason of this postponing in most MSs is related to the insufficiency of the current FCI system that is needed to enable proper risk categorisation of farms/animals [16]. Another problem with visual-only inspection experienced so far is related to the trade agreements negotiated with countries outside the EU.
3. What is next?

The thorough development and fine-tuning of the new meat safety assurance system are necessary steps before its full implementation, which is expected to be relatively slow and in line with testing of the new system’s feasibility in practice. To increase efficiency of regulatory controls in the modernisation process, different existing meat safety systems will have to be steadily harmonised under the general principles and framework of the meat safety assurance system to the extent achievable.

New challenges are anticipated with further evolution of the system. To enable the additional revision of relevant legislation, the European Commission will need further scientific inputs from the EFSA. Hazard identification and risk ranking will be regularly revisited and performed at regional level, which might lead to some modifications of the proposed system. Furthermore, dynamics of the new system’s development process are expected to be variable across different countries and consequential to the alignment of current private food safety standards in meat industries with the new system.

Numerous knowledge gaps are still present and further scientific research needs to address them before the full practical implementation of the new system. Research on harmonisation and advancing the use of FCI in risk categorisation of incoming animals is needed to enable adequate carcass processing as well as meat inspection intensity. Among other things, this effort is needed to clarify use of multi-serological herd profiles for priority hazards, to improve various serological tests in animals for slaughter, to assess the effectiveness of harmonised epidemiological criteria in risk categorisation of farms/animals and abattoirs, and to improve the FCI forward and backward flows [17-19]. To support future post-mortem inspection, research should include further development of imaging technologies to detect lesions and faecal contamination [20]. Also, various options of future manual post-mortem meat inspection of the high risk animals (e.g. away from the slaughter-line to avoid any accompanying cross-contamination), and risk assessment of the cross-contamination due to palpations and incisions merit further investigations [5,7]. Assessment of the impact of visual-only inspection and contribution of specific meat inspection tasks to public health and animal health and welfare requires deeper studies [21]. Also, measures to compensate for any omitted/reduced palpations and incisions are proposed [22], but need to be assessed when practically tested; furthermore, new meat inspection alternatives targeting specific hazards should be developed [23]. Investigations to advance the use of risk reduction capacities of abattoirs are needed for the new meat safety assurance system. Promising meat decontamination technologies are proposed [24] and further studies should be carried out to optimise them and to practically assess their performances in abattoirs. New methodologies for assessing abattoir process hygiene and for risk categorisation of abattoirs need further examination as well as practical optimisation [25]. Identification of cost-effective monitoring programs for residues of veterinary drugs and other substances that are unwanted in meat [26] and use of responsive regulation approach in modernisation of meat controls [27] should be the themes of future investigations.

For the proper functioning of the new system, defining different roles and responsibilities is of the utmost importance. The risk managers are expected to play a pivotal role here, and they will link national regulatory authorities with meat industries by implementing efficient regulatory controls. They will choose which control options will be applied to ensure the meat safety targets are achieved and to make the overall most cost-effective contribution to public health. They will have to weigh up where the risks associated with non-compliance are highest, and thus where the most intrusive enforcement responses are required. This emphasises the need for proper training of the future risk managers as well as all the other participants in the new meat safety assurance system.

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