Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Finland

DEVELOPING OFFICIAL CONTROL IN FINNISH SLAUGHTERHOUSES

Jenni Luukkanen

ACADEMIC DISSERTATION

To be presented, with permission of the Faculty of Veterinary Medicine, University of Helsinki, for public examination in Walter Hall of the EE building, Agnes Sjöbergin katu 2, Helsinki, on 25th of January 2019, at 12 noon.

Helsinki 2018

Supervising Professors
Professor Emeritus Hannu Korkeala, DVM, PhD, MSocSc
Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Helsinki, Finland

Professor Maria Fredriksson-Ahomaa, DVM, PhD
Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Helsinki, Finland

Supervisors
Docent Janne Lundén, DVM, PhD
Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Helsinki, Finland

Docent Mari Nevas, DVM, PhD
Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Helsinki, Finland

Professor Maria Fredriksson-Ahomaa, DVM, PhD
Department of Food Hygiene and Environmental Health
Faculty of Veterinary Medicine
University of Helsinki
Helsinki, Finland

Reviewed by

Professor Emeritus Sava Buncic, DVM, MScVM, PhD
Department of Veterinary Medicine
Faculty of Agriculture
University of Novi Sad
Novi Sad, Serbia

Professor Ivar Vågsholm, DVM, MPVM, MSc (ag econ) PhD
Department of Biomedical Sciences and Veterinary Public Health
Swedish University of Agricultural Sciences (SLU)
Uppsala, Sweden

Opponent

Ari Hörman, DVM, PhD, MPH
Docent, University of Helsinki
Chief Veterinary Officer
Finnish Defence Forces
Helsinki, Finland

ISBN 978-951-51-4781-3 (pbk.)
ISBN 978-951-51-4782-0 (PDF)

Unigrafia
Helsinki 2018

ABSTRACT

Official control in slaughterhouses, consisting of meat inspection and food safety inspection, has an important role in ensuring meat safety, animal health and welfare, and prevention of transmissible animal diseases. Meat inspection in the European Union (EU) includes the inspection of food chain information, live animals (ante-mortem inspection), and carcasses and offal (post-mortem inspection). Food safety inspections are performed to verify slaughterhouses' compliance with food safety legislation and are of the utmost importance, especially if slaughterhouses' self-checking systems (SCSs) fail. The aim of this study was to investigate the prerequisites for official control such as the functionality of the task distribution in meat inspection and certain meat inspection personnel-related factors. In addition, needs for improvement in slaughterhouses' SCSs, meat inspection, and food safety inspections, including control measures used by the official veterinarians (OVs) and their efficacy, were examined. In the EU, competent authorities must ensure the quality of official control in slaughterhouses through internal or external audits, and the functionality of these audits was also studied.

Based on our results, meat inspection personnel (OVs and official auxiliaries [OAs]), slaughterhouse representatives, and officials in the central authority were mainly satisfied with the functionality of the present task distribution in meat inspection, although redistributing ante-mortem inspection from the OVs to the OAs was supported by some slaughterhouse representatives due to perceived economic benefit. Ante-mortem inspection was assessed as the most important meat inspection task as a whole for meat safety, animal welfare, and prevention of transmissible animal diseases, and most of the respondents considered it important that the OVs perform ante-mortem inspection and whole-carcass condemnation in red meat slaughterhouses.

In a considerable number of slaughterhouses, OA or OV resources were not always sufficient and the lack of meat inspection personnel decreased the time used for food safety inspections according to the OVs, also affecting some of the red meat OAs' post-mortem inspection tasks. The frequency with which OVs observed post-mortem inspection performed by the OAs varied markedly in red meat slaughterhouses. In addition, roughly one-third of the red meat OAs did not consider the guidance and support from the OVs to be adequate in post-mortem inspection. In various parts of this study, OVs' demand for

increased guidance and support from their superiors in control actions of a difficult nature was emphasized.

According to our results, the most common non-compliance in slaughterhouses concerned hygiene such as cleanliness of premises and equipment, hygienic working methods, and maintenance of surfaces and equipment. Chief OVs in a few smaller slaughterhouses reported more frequent and severe non-compliances than other slaughterhouses, and in these slaughterhouses the usage of written time limits and enforcement measures by the OVs was more infrequent than in other slaughterhouses. Deficiencies in documentation of food safety inspections and in systematic follow-up of corrections of slaughterhouses' non-compliance had been observed in a considerable number of slaughterhouses. In meat inspection, deficiencies in inspection of the gastrointestinal tract and adjacent lymph nodes were most common and observed in numerous red meat slaughterhouses.

Internal audits performed to evaluate the official control in slaughterhouses were considered necessary, and they induced correction of observed non-conformities. However, a majority of the interviewed OVs considered that the meat inspection should be more thoroughly audited, including differences in the rejections and their reasons between OAs. Auditors, for their part, raised a need for improved follow-up of the audits.

Our results do not give any strong incentive to redistribute meat inspection tasks between OVs, OAs, and slaughterhouse employees, although especially from the red meat slaughterhouse representatives' point of view the cost-efficiency ought to be improved. Sufficient meat inspection resources should be safeguarded in all slaughterhouses, and meat inspection personnel's guidance and support must be emphasized when developing official control in slaughterhouses. OVs ought to focus on performing follow-up inspections of correction of slaughterhouses' non-compliance systematically, and also the documentation of the food safety inspections should be developed. Hygiene in slaughterhouses should receive more attention; especially in slaughterhouses with frequent and severe non-compliance, OVs should re-evaluate and intensify their enforcement. The results attest to the importance of internal audits in slaughterhouses, but they could be developed by including auditing of the rejections and their underlying reasons and uniformity in meat inspection.

ACKNOWLEDGEMENTS

This study was carried out at the Department of Food Hygiene and Environmental Health, Faculty of Veterinary Medicine, University of Helsinki, during 2013-2018. The Ministry of Agriculture and Forestry, the Doctoral Programme in Food Chain and Health, and the Finnish Veterinary Foundation are thanked for financial support.

I am deeply grateful to all of my supervisors, Docent Janne Lundén, Docent Mari Nevas, the current Head of the Department of Food Hygiene and Environmental Health, and Professor Maria Fredriksson-Ahomaa, for guidance, encouragement, and input of time and knowledge. It has been a great pleasure to work with all of you! Without Janne, the project would not have been possible. Thank you for planning a straightforward project, for going through the trouble of applying for funding, and for always being available, prepared to help and give new perspectives. I also thank Professor Emeritus Hannu Korkeala, the former Head of the Department, for creating an enthusiastic working environment and for supporting my work.

Professor Emeritus Sava Buncic and Professor Ivar Vågsholm are acknowledged for skilfully reviewing this thesis, and I am obliged to Docent Ari Hörman for accepting the role on an opponent at my thesis defence. Carol Ann Pelli is warmly thanked for editing the English language of the manuscript. I'm deeply grateful to the meat inspection personnel, slaughterhouse representatives, and officials guiding and organizing meat inspection in Evira for contributing their time to this study. I also thank the project's steering group and my thesis follow-up group, Riikka Keto-Timonen and Annamari Heikinheimo, for valuable insights and guidance.

My heartfelt thanks go to all of my colleagues at the Department and elsewhere for sharing this journey. Johanna Laine, Miia Ketoharju, Kristian Lindqvist, Tomi Tikkanen, Maija-Liisa Mäkinen and Heimo Tasanen have been helpful in practical matters. The peer support, discussions, and advice have been vital, especially during the last steps of the thesis. I particularly acknowledge Karoliina Kettunen, Suvi Joutsen, Marie Verkola, Minna Päivärinta, Sara Kovanen, Selma Mahiout, Anna Pöntinen, Anna Mertaoja, Mariella Aalto-Araneda, Marjo Ruusunen, Anna Sarvela, Jasmin Joenperä, Sofia Väärikkälä, Tiina Läikkö-Roto, Riikka Laukkanen-Ninios, and Eva Marami. Last, but not least, I thank my dear long-term office-mate Jenni Kaskela for being the lovely, supportive person that she is.

I'm truly grateful to the many wonderful people in my life for restorative activities, encouragement, and understanding during this process. Ansku, I could not have asked for a better friend. Special thanks also to my high school friends, to course-mates, and to the Anttila family for warm friendship, and to Saga for her delightful presence.

Finally, I thank my dear family. My grandparents have enriched also this period in my life with humour and love, serving as examples of great determination and perseverance. To my sister's partner Riku and my newest acquaintanceship with Oliver, I'm grateful for many laughs and good company and for providing me with the most delightful news during this study. My parents Elina and Ismo and my sister Johanna, I thank for supporting me in every way possible. I am so lucky; without you, many things in my life would have been harder.

Keep looking up... That's the secret of life... -Snoopy

CONTENTS

Abstract....4

Acknowledgements.... 6

Contents.... 8

List of original publications.... 11

Abbreviations....12

1 Introduction....13

2 Review of the literature 15

2.1 Regulative framework for official control in slaughterhouses in the EU and in Finland....15

2.2 Organization of slaughterhouse control in the EU and in Finland 16

2.3 Pressure to redistribute control tasks in slaughterhouses and possible consequences 18

2.4 Perceptions of distribution of control tasks 19

2.5 Number, training, and skills of official control personnel 20

2.6 Meat inspection procedures and their importance 21

2.7 Food safety inspections in slaughterhouses 24

2.8 Control measures and factors affecting efficacy of food safety inspections 25

2.9 Deficiencies observed in official control of slaughterhouses 28

2.9.1 Deficiencies in meat inspection 28

2.9.2 Deficiencies in food safety inspections.... 28

2.10 Self-checking systems and their implementation in meat plants 29

2.10.1 Content and significance of self-checking systems.... 29

2.10.2 Importance of hygiene and temperature control in slaughterhouses 30

2.10.3 Food business operator-related factors affecting compliance 31

2.10.4 Non-compliance in slaughterhouses and other meat plants 33

2.11 Auditing as a tool for improving official control 40

3 Aims of the study 42

4 MaterialS and methods 43

4.1 Questionnaires (I, II, III) 43

4.2 Internal audit reports (IV) 44

4.3 Interviews and their qualitative analysis (IV) 44

4.4 Statistical analysis (I, II, III, IV) 45

4.4.1 Statistical analysis of the questionnaires (I, II, III) 45

4.4.2 Statistical analysis of the internal audit reports (IV) 46

4.4.3 Statistical analysis of the interviews (IV) 46

5 Results 47

5.1 Questionnaire response rates and respondents (I, II, III) 47

5.2 Prerequisites for high-quality official control in slaughterhouses (I, II, III) 48

5.2.1 Functionality of meat inspection tasks and their distribution (I) 48

5.2.2 Perceived importance of meat inspection tasks (I) 49

5.2.3 Changing the distribution of meat inspection tasks (I) 50

5.2.4 Sufficiency of the number of meat inspection personnel (II) 52

5.2.5 Meat inspection skills and evaluation of official auxiliaries' performance (II) 53

5.2.6 Independence from the slaughterhouse in meat inspection (II) 54

5.2.7 Official veterinarians' expertise in food safety legislation and administrative skills (III) 54

5.2.8 Further training of meat inspection personnel (II) 54

5.2.9 Guidance and support given to meat inspection personnel (II) 55

5.3 Non-compliance of slaughterhouse self-checking systems (III) 56

5.4 Control measures used by the official veterinarians and their efficacy (III).....57

5.5 Deficiencies in official control and their correction..... 58

5.5.1 Deficiencies in meat inspection (IV)..... 58

5.5.2 Deficiencies in food safety inspections (IV) 59

5.6 Internal audits..... 60

5.6.1 Necessity, benefits, and frequency of internal audits (IV) . 60

5.6.2 Needs for improvement of internal audits (IV)..... 60

6 Discussion 62

6.1 Improving prerequisites for high-quality official control in red meat and poultry slaughterhouses..... 62

6.1.1 Meat inspection tasks and their distribution 62

6.1.2 Meat inspection personnel-related prerequisites..... 64

6.1.3 Demand for increased guidance for official veterinarians . 66

6.2 Non-compliance of slaughterhouses and improvement of self-checking systems.....67

6.3 Enhancing efficacy of official control 68

6.4 Improving auditing procedures..... 70

7 Conclusions.....72

References 74

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Luukkanen, J., Kotisalo, N., Fredriksson-Ahomaa, M., & Lundén, J. (2015). Distribution and importance of meat inspection tasks in Finnish high-capacity slaughterhouses, *Food Control*, *57*, 246–251. doi:10.1016/j.foodcont.2015.03.044.

II Luukkanen, J., Fredriksson-Ahomaa, M., Nevas, M., & Lundén, J. (2017). Prerequisites for high-quality official control in Finnish slaughterhouses, *Food Control, 79*, 50-56. doi:10.1016/j.foodcont.2017.03.020.

III Luukkanen, J., & Lundén, J. (2016). Compliance in slaughterhouses and control measures applied by official veterinarians, *Food Control*, *68*, 133–138. doi:10.1016/j.foodcont.2016.03.033.

IV Luukkanen, J., Nevas, M., Fredriksson-Ahomaa, M., & Lundén, J. (2018). Developing official control in slaughterhouses through internal audits. *Food Control*, 90, 344-351. doi: 10.1016/j.foodcont.2018.03.014

The publications are referred to in the text by their Roman numerals and have been reprinted with the permission of their copyright holder, Elsevier.

The author had the main responsibility for collecting and analysing the data and writing the manuscripts of all publications. All co-authors participated in designing the studies and editing the manuscripts.

ABBREVIATIONS

BSE	Bovine Spongiform Encephalopathy
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FBO	Food Business Operator
FCI	Food Chain Information
FDA	Food and Drug Administration
FSA	Food Standards Agency
FSIS	Food Safety and Inspection Service
FVO	Food and Veterinary Office
HACCP	Hazard Analysis and Critical Control Points
OA	Official Auxiliary
OV	Official Veterinarian
SCS	Self-Checking System
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

1 INTRODUCTION

In the European Union (EU), meat is an important source of foodborne infections (Centers for Disease Control and Prevention, 2017; European Food Safety Authority [EFSA] & European Centre for Disease Prevention and Control [ECDC], 2016), and new challenges for meat safety, such as higher demand for minimally processed products, higher numbers of consumers at risk for infection, and increased international trade (Sofos, 2008), have emerged. Hygiene deficiencies in slaughterhouses occur (Alban et al., 2011 ; Cook et al., 2017; European Commission [EC], 2013 ; Food and Veterinary Office [FVO], 2002, 2010, 2013; Lewis et al., 2013; Masanganise et al., 2013; Pacholewicz et al., 2016; Tuttle et al., 1999), and meat and meat products have also been the most common foodstuff in the agri-food chain to be linked to food frauds in the EU (EC, 2016). All of these factors attest to the importance of official control in slaughterhouses, which in the EU consists of meat inspection and food safety inspection. The main objectives of meat inspection are to prevent meatborne disease in consumers, to secure animal health and welfare, to prevent transmissible animal diseases, and to protect consumers from mislabelled or adulterated meat (EU, 2004d). Food safety inspections, on the other hand, aim to verify slaughterhouses' compliance with food safety legislation (EU, 2004d), ensure good hygiene practices, and verify the implementation of Hazard Analysis and Critical Control Points (HACCP)-based self-checking systems (SCSs) (EU, 2004e).

Legislation concerning meat safety has traditionally been rather comprehensive in the EU (Lawless & Wiedemann, 2011). The present legislation prescribes, for instance, the distribution of the official control tasks, their content, and certain requirements for the official control staff, such as sufficiency, skills, training, and supervision. According to the EU legislation, only poultry and lagomorph slaughterhouses' staff can perform meat inspection under the supervision of the official veterinarians (OVs), but in red meat slaughterhouses official auxiliaries (OAs) must work for the central authority or an independent control body (EU, 2004d). In the past few decades, changes to the content of meat inspection and task distribution have aroused interest in making official control more risk-based and cost-efficient (Anonymous, 2012, 2014; Carneiro & Kaneene, 2017; Food Standards Agency [FSA], 2007; Lawless & Wiedemann, 2011; Pope et al., 2013 ; Webber et al., 2012). Pilot projects that have tested new ways to organize meat inspection have been conducted (Det Norske Veritas, 2011; Netherlands Food and

Consumer Product Safety Authority, 2013), but scientific literature on the impact of different organization models on official control is scarce.

Apart from meat inspection, slaughterhouses in the EU have the main responsibility to ensure the safety of their products (EU, 2002b). However, implementation of the SCSs in slaughterhouses is not always successful (Alban et al., 2011; FVO, 2002, 2010; Kotsanopoulos & Arvanitoyannis, 2017a; Pinillos & Jukes, 2008). Thus, it is of the utmost importance that in cases where slaughterhouses' self-checking fails, official control detects and addresses the non-compliance.

Various audits are performed to ensure the quality of official control, composed of multiple factors such as consistency, uniformity, competentency, efficacy, and impartiality (EU, 2004e; National Audit Systems Network, 2014). In the EU, the EC is obligated to carry out audits to member states to verify that official controls are in accordance with EU legislation and the national control plans (EU, 2004e). These audits are performed by the Directorate General (DG) Health and Food Safety, formerly known as the FVO, and part of the audits evaluate official control in slaughterhouses. In each EU country, also competent authorities must conduct either internal or external audits of slaughterhouses to ensure the sufficiency of official control (EU, 2004e). Apart from reports of the FVO audits, few scientific studies have examined deficiencies in official control in slaughterhouses, control measures used by the OVs and their efficacy, or non-compliance of slaughterhouses.

This thesis aims to reveal how the official control, including task distribution and meat inspection personnel-related prerequisites, control measures used by the OVs, and internal audits of official control could be developed to improve the quality of meat and food safety inspections in Finland. For the development of official control, it is also important to know the types and frequencies of non-compliance in Finnish slaughterhouses.

This thesis concentrates on meat and food safety inspections in Finnish slaughterhouses, excluding small-scale slaughterhouses (Ministry of Agriculture and Forestry, 2011, 2014a). The focus is on meat safety, and therefore, for instance, control measures of the OVs or non-compliance of slaughterhouses' SCSs in relation to animal welfare are not covered.

2 REVIEW OF THE LITERATURE

2.1 REGULATIVE FRAMEWORK FOR OFFICIAL CONTROL IN SLAUGHTERHOUSES IN THE EU AND IN FINLAND

In the EU, meat safety has traditionally been rather heavily regulated and one of the first pieces of harmonized legislation concerns meat inspection (Lawless & Wiedemann, 2011). The harmonization is largely due to the initial aim of the EU to construct a common single market for its member states (Lawless & Wiedemann, 2011). Due to several disease outbreaks and food contamination scandals, including the bovine spongiform encephalopathy (BSE) crisis in the last quarter of the last century, the EC adopted the White Paper on Food Safety in 2000, which included a number of recommendations aiming to increase food safety, regain consumer confidence in the food industry, and improve the traceability of food products (Dwinger et al., 2007; EC, 2000). Based on the White Paper, new more risk-based legislation was adopted in 2002 and 2004 (Dwinger et al., 2007; Rusconi, 2016), including the General Food Law (EU, 2002b) and the Hygiene Package (EU, 2002a, 2004a,b,c,d).

Of the regulations adopted in 2002 and 2004, the General Food Law allocates the overall responsibility for producing safe food to the food business operators (FBOs), whereas competent authorities are merely to verify correct implementation of the legislation (EU, 2002b). However, the responsibility for meat inspection lies with the competent authorities (EU, 2004d). Regulation EC No. 852/2004 introduces general hygiene requirements to be upheld by FBOs at all stages of the food chain (EU, 2004b), and Regulation EC No. 853/2004 describes the hygiene requirements for FBOs handling food of animal origin (EU, 2004c). The main principles of official food controls, such as that the official control should be risk-based, regular, competent, impartial, independent, consistent, transparent, and effective, are stated in Regulation 882/2004 (EU, 2004e). More specific requirements in relation to official control in slaughterhouses, such as its organization and content, are presented in Regulation EC No. 854/2004 (EU, 2004d).

In Finland, national legislation further specifies the aforementioned regulations. The Food Act 23/2006 (Ministry of Agriculture and Forestry, 2006) lays out requirements for food and the conditions in which it is handled, and for FBOs and food control at all stages in production, processing, and distribution. Regulation 795/2014 on food hygiene in food establishments (Ministry of Agriculture and Forestry, 2014a) covers, for instance, hygiene of

premises and operations, and implementation of SCS. Regulation 590/2014 on meat inspection presents organization of meat inspection in slaughterhouses and meat inspection tasks and their content (Ministry of Agriculture and Forestry, 2014b).

Some changes regarding food safety legislation are at hand. Regulations EC No. 882/2004 and EC No. 854/2004 have recently been reviewed and will after a transition period be replaced by the Official Controls Regulation (EU) 2017/625, with an extended scope (EU, 2017). The new regulation covers official controls to verify compliance with food and feed law, animal health and welfare, animal by-product rules, and plant health. The rules will gradually become applicable, mainly in December 2019 (EU, 2017). The national Food Act 23/2006 is also under review and a new substitutive legislation has already been outlined (Ministry of Agriculture and Forestry, 2018).

Official control of slaughterhouses is under the ordinance of public administration, and therefore, the principles of good governance must also be taken into account (European Communities, 2005; Lepistö, 2008; Lepistö & Hänninen, 2011). Every FBO's basic right is to be equally treated by the authority (European Communities, 2005; Lepistö, 2008; Lepistö & Hänninen, 2011), and OVs have a legislative duty to apply laws uniformly (EU, 2004b; Ministry of Justice, 2003).

2.2 ORGANIZATION OF SLAUGHTERHOUSE CONTROL IN THE EU AND IN FINLAND

Official control of slaughterhouses comprises meat inspection and food safety inspection. Meat inspection in the EU includes inspection of food chain information (FCI), ante-mortem inspection of live animals, post-mortem inspection of carcasses and offal, and feedback to farmers (EU, 2004d). Food safety inspections are performed to verify slaughterhouses' compliance with food safety legislation, ensure good hygiene practices, and verify the implementation of HACCP-based SCSs (EU, 2004d), decribed in Section 2.9. OVs are responsible for both meat and food safety inspections in slaughterhouses, and the main rule is that at least one OV must be present in slaughterhouses during ante-mortem and post-mortem inspections (EU, 2004d). OAs have permission to assist in post-mortem inspection and in practical tasks of ante-mortem inspection under supervision of the OV (EU, 2004d). In relation to food safety inspections, OAs can only collect information regarding good hygienic practices and HACCP-based procedures according to the legislation (EU, 2004d).

In the EU, two main meat inspection organizational models exist: OAs may be employed by the poultry or lagomorph slaughterhouses, but in red meat slaughterhouses (processing bovines, pigs, horses, sheep, and goats) OAs are employed by the authority or by an independent control body (EU, 2004d). For instance, the Netherlands has a private independent agency, whose OAs perform post-mortem inspections (Anonymous, 2014). Also other organizations are possible in the EU, e.g. the majority of OVs and some of the red meat OAs are employed by sub-contracted agencies in the United Kingdom (UK) (FVO, 2015).

In Finland, the Ministry of Agriculture and Forestry is the supreme authority steering and controlling the enforcement of and compliance with food safety legislation. During the study period the Finnish Food Safety Authority Evira was responsible for the organization, steering, and guidance of official control in slaughterhouses and adjacent cutting plants, except for reindeer slaughterhouses (Evira, 2017c). In Evira's control department, the meat inspection unit was responsible for leading and organizing meat inspection personnel (OVs and OAs) in Finnish slaughterhouses, while the food hygiene unit was responsible for leading, developing, and guiding slaughterhouse control (Evira, 2016d; Hatakka, 2011). In the year 2016, Evira was responsible for organizing official control of 19 slaughterhouses, 45 small-scale slaughterhouses, and 6 game slaughterhouses (Evira, 2017c). Poultry OAs are employed by the slaughterhouses, but red meat OAs work for Evira. In slaughterhouses, 41 full-time OVs and 50 red meat OAs were employed, and, in addition, 82 OVs and 2 red meat OAs were commissioned to work in small-scale slaughterhouses in 2016 (Evira, 2017c). Each slaughterhouse has a chief OV who is responsible for leading and overseeing the rest of the meat inspection personnel in the slaughterhouse. In 2007, Finnish slaughterhouses were divided into four regional areas, and one OV from each of these areas worked part-time as a regional director, leading and guiding the meat inspection personnel in the area (Rahkio, 2009). In 2013, separate, full-time regional directors were hired for each area (Evira, 2014b). During the study period the number of regional directors varied, being five at the most, but by the year 2017, the number had decreased to three (Evira, 2016d).

In the 1970s and 1980s, major changes regarding the responsibilities in meat inspection were made in Finland. Before 1976, OVs had been working for the slaughterhouses, but were transferred under the central authority due to the highlighted importance of meat inspection for food safety and hygiene (Anonymous, 1975). For the same reason and because export countries demanded that meat inspection should be performed by the authority, red

meat OAs' employer was also changed to the central authority in 1983 (Anonymous, 1982).

2.3 PRESSURE TO REDISTRIBUTE CONTROL TASKS IN SLAUGHTERHOUSES AND POSSIBLE CONSEQUENCES

The role of OVs in ante-mortem and post-mortem inspections is of particular significance in the present legislation (EU, 2004d); OVs constitute marked costs for the industry and taxpayers (Lawless & Wiedemann, 2011). For economic reasons, the distribution of official control tasks in slaughterhouses has been widely discussed in the EU (Alban et al., 2011; Anonymous, 2006c, 2008b, 2013b) and also worldwide (Anonymous, 2012; 2014; Carneiro & Kaneene, 2017; Webber et al., 2012). The approach of demanding full-time government inspectors to be present in slaughterhouses, but not in businesses operating with more dangerous activities has been questioned (FSA, 2007), and the approach has even been stated to be in conflict with the legislative principle of the primary responsibility being with the FBO (Riedl & Riedl, 2008). Thus, the idea of allowing red meat slaughterhouses' staff to perform meat inspection procedures has sparked some interest (Anonymous, 2006c; Rahkio, 2009; Webber et al., 2012).

Regulation EC No. 854/2004 allows member states to conduct pilot projects to try out new approaches in meat inspection so long as meat safety is not jeopardized (EU, 2004d). For instance, in the UK, the act of assigning ante-mortem inspection of poultry and of prime, young red meat animals from the OVs to the OAs was assessed to have little impact on inspection results (Det Norske Veritas, 2011). An important reason for why the impact was assessed as minimal was that the number of animals rejected as not suitable for human consumption was stated to be small in the first place (Det Norske Veritas, 2011). However, the results highlighted the importance of ante-mortem inspection and appropriate skills, training, experience, and veterinary support of the person performing the inspections (Det Norske Veritas, 2011). In the Netherlands, assigning ante-mortem inspection from the OVs to well-trained and experienced poultry OAs, with sufficient veterinary supervision, was also evaluated as having limited effect on meat safety (Netherlands Food and Consumer Product Safety Authority, 2013); however, the impact on animal welfare and health was not considered.

Decreasing the supervision in slaughterhouses has also been reported to have undesirable effects. In the Netherlands, official control performed by the authority in Dutch slaughterhouses has been decreased, and, for instance, the

OAs in red meat slaughterhouses are employed by an independent agency (Anonymous, 2014). As a consequence, the quality of control has been assessed as declining (Dutch Safety Board, 2014). The capability of slaughterhouses to cope with increased responsibility for the meat safety has been questioned as numerous deficiencies in hygiene have been identified (Dutch Safety Board, 2014). Similar results have also been reported from the United States (USA). There, transferring responsibility for meat safety to a great extent to the slaughterhouses at the beginning of the century led to rather frequent faecal contamination of carcasses, usage of unqualified meat inspection personnel, and pressure from slaughterhouse management to provide certain meat inspection decisions (Nestor & Hauter, 2000).

2.4 PERCEPTIONS OF DISTRIBUTION OF CONTROL TASKS

Previous studies on different parties' perceptions of the task distribution of official control in slaughterhouses are rare. In a study conducted in the UK, meat inspection personnel speculated that allowing red meat slaughterhouses' employees to perform post-mortem inspection would most likely result in an increased risk to the general public (Pope et al., 2013). A potentially inadequately trained slaughterhouse employee performing post-mortem inspection and a perceived conflict of interest were believed to lead to poorer quality of meat inspection. However, OVs in poultry slaughterhouses were satisfied with the work of the poultry OAs employed by the slaughterhouse, and none wished to return to government-employed post-mortem inspection. However, some OVs mentioned that OAs in red meat slaughterhouses require more knowledge and skills than those in poultry slaughterhouses, and therefore, also questioned slaughterhouse-employed post-mortem inspection in red meat slaughterhouses. Many slaughterhouse operators' considered ante-mortem inspection as replication of tasks that had already been carried out by slaughterhouse employees, and therefore, supported assigning the task to their employees. Although few red meat slaughterhouses assessed that their employees could perform also post-mortem inspection, the majority of the slaughterhouses perceived independent OAs as necessary, especially for consumer confidence. Improving general trust in the meat industry and also in exports and reducing temptation and possibilities for fraud were mentioned as reasons why independent post-mortem inspection was important (Pope et al., 2013).

In the UK, also consumers' views on the distribution of meat inspection tasks have been investigated, and, for instance, a cost-cutting motive was not valued over meat safety when considering changes to the task distribution (TNS-BMRB, 2010). In British slaughterhouses, ante-mortem inspection by OVs was first introduced in 2004 due to reformed EU regulation, and after the consumers taking part in the survey were informed about this, some of them were responsive to the idea of ante-mortem checks being carried out by the OAs (TNS-BMRB, 2010). However, part of the consumers considered OVs' expertise to be important in ante-mortem inspection and were worried that assigning the task to OAs would not reduce costs, particularly if OVs were still regularly consulted in complicated cases or if OAs lacked competency and sufficient training for the task (TNS-BMRB, 2010).

2.5 NUMBER, TRAINING, AND SKILLS OF OFFICIAL CONTROL PERSONNEL

According to the EU legislation, the number of official staff to carry out slaughterhouse control must be sufficient and the speed of the slaughter line must allow proper inspection (EU, 2004d). The importance of a sufficient number of OAs was emphasized in Canada in 2012, when a meatborne *Escherichia coli* 0157:H7 outbreak caused 18 consumers to become ill (Lewis et al., 2013). The outbreak investigations revealed that in the slaughterhouse that had produced the meat in question the slaughter line speed had been too fast for thorough meat inspection, and a high workforce turnover together with a meat inspection personnel shortage existed (Lewis et al., 2013). According to audit results, inadequate numbers of meat inspection personnel have lowered the quality of control in some European Countries (European Free Trade Association [EFTA] Surveillance Authority, 2014; FVO, 2002), but more precise information regarding these effects cannot be found.

For the quality of official control, it is important that the staff performing official control is well-versed with the relevant legislation, its requirements for FBOs, and their own rights and responsibilities under the legislation (Food and Agriculture Organization of the United Nations [FAO] & World Health Organization [WHO], 2003). In the EU, OVs must have extensive training in various subjects (EU, 2004d), and also OAs' education includes 400 hours of practical training in slaughterhouses and 500 hours of theoretical training in a wide range of subjects (EU, 2004d). Both OVs and OAs must maintain up-to-date knowledge through regular, and wherever possible, annual, continuing education activities and through professional literature (EU, 2004d). In

Finland, the central authority organized further training also for poultry OAs until 2008 (FVO, 2009b), but at the time of this study, further training was organized centrally only for red meat OAs.

In 2003, the training of OAs varied markedly in EU countries and a lack of emphasis on OA training existed (Leslie, 2003). In some EU countries, insufficient qualification, technical knowledge, and experience of meat inspection personnel have been assessed to weaken the level of supervision of slaughterhouses (Alban et al., 2011), and also the training of Finnish poultry OAs has been assessed as insufficient by the FVO (FVO, 2009b).

In Finland, the FVO has also detected deficiencies in the performance tests for poultry OAs (FVO, 2009b) that the OVs are obligated to conduct for slaughterhouse-employed OAs to ensure the quality of post-mortem inspection (EU, 2004d). However, proper written instructions for the OVs on how to conduct these performance tests were not compiled until the year 2015 in Finland (Evira, 2015b).

2.6 MEAT INSPECTION PROCEDURES AND THEIR IMPORTANCE

The principles and procedures of meat inspection were established at the end of the 19th century, when infectious animal diseases with attendant zoonotic risks were common (Alban et al., 2011; Hathaway & McKenzie, 1991). Major improvements in animal and human health were achieved through the organization of meat inspection (Edwards et al., 1997). By the end of the 1960s, classical endemic diseases, such as bovine tuberculosis, had largely been eradicated in developed countries, dramatically reducing the likelihood of discovering the associated lesions at meat inspection (Grossklaus, 1987). In recent years, it has been a concern that meat inspection might not detect and control today's major meatborne pathogens (Anonymous, 2014; Edwards et al., 1997; Hathaway & McKenzie, 1991; Uzal et al., 2002), including *Campylobacter*, *Salmonella* spp., Shiga toxin-producing *E. coli*, and *Toxoplasma gondii* (Batz et al., 2012; Edwards et al., 1997). Already in 1984, revision of meat inspection protocols was discussed internationally at a conference on meat hygiene in the Netherlands (Huey, 2012). Even after the implementation of the Hygiene Package, considerable interest towards a more modernized, risk-based, and cost-efficient meat inspection has remained in the EU (Anonymous, 2014; FSA, 2007; Lawless & Wiedemann, 2011).

In 2010, EFSA convened an expert panel at the request of the EC to assess current approaches to meat inspection and has since published opinions that

provide a scientific basis for the modernization of meat inspection across the EU (EFSA, 2011, 2012, 2013a,b). For instance, it was concluded that the risk of microbial cross-contamination by palpation or incisions used in post-mortem inspection is higher than the risk associated with potentially decreased detection of conditions targeted by these techniques (EFSA, 2011), and therefore, the post-mortem inspection of swine has been changed to primary visual inspection, omitting routine palpation and incisions (EU, 2014a,b). Although the legislation has changed, the visual meat inspection of swine has not been in operation in Finland yet (Evira, 2017c), mainly because export countries still require traditional meat inspection. However, for instance, Germany, the Netherlands, and Denmark have already moved towards more visual meat inspection (Alban et al., 2011; Anonymous, 2014).

In addition to EFSA, studies in various EU countries have also questioned the content of current post-mortem inspection (FSA, 2011; Hill et al., 2013, 2014; Stärk et al., 2014) and deemed that moving towards visual inspection is important for decreasing the risk of cross-contamination (Anonymous, 2008a; Mousing et al., 1997). Although the gastrointestinal tract can show signs of enteritis (Buncic, 2006; Jensen et al., 2008), the mandatory inspection of the intestines has been assessed to have very limited impact on public and animal health (Blagojevic et al., 2015). The traditional meat inspection has also been assessed to have low sensitivity for intestinal and parasitic disorders (Bonde et al., 2010). Meat inspection as such cannot detect some of the infecting stages of parasites (Emameh et al., 2018), and new techniques, such as molecular biology techniques, have been recommended to diagnose certain parasites (Emameh et al., 2018).

FCI was a novel element in the Hygiene Package and has been considered a key tool in a more risk-based approach to meat inspection (EFSA, 2011, 2012, 2013a; Lawless & Wiedemann, 2011). FCI comprises data received from the farmer, including information on the animal's origin, health status, and welfare, veterinary medicinal products or other treatments administered to animals, on-farm practices, and housing conditions (EU, 2004c). Slaughterhouses must receive, evaluate, and act upon this information that should be provided to the slaughterhouse at least 24 hours before the arrival of animals to the slaughterhouse, and must also submit the information to the OVs for checking and analysis (EU, 2004c). The FCI should be used to categorize animals, herds, flocks, and farms into risk-based groups (Anonymous, 2014; Huey, 2012), but recent research indicates that the information cannot be utilized as recommended. Felin et al. (2016) concluded that the FCI lacks important information concerning swine, and that serological profiles, historical meat inspection results of swine from the same

holding, and some well-chosen symptoms with proper guidelines for reporting should be included in the future. Other deficiencies associated with the FCI, such as missing information especially for cattle and sheep (Buncic et al., 2014; Det Norske Veritas, 2011; EFSA, 2011, 2013a), farmers' insufficient understanding of the FCI, and improper completion of the forms, have been reported (Anonymous, 2013a). Education of the farmers and slaughterhouse staff about the usefulness of the FCI and how it could result in differentiated and more cost-effective meat inspection has been recommended (Alban et al., 2011).

The FCI must be taken into account when the OVs carry out ante-mortem inspection of all animals 24 hours before slaughter (EU, 2004d). Ante-mortem inspection has been assessed as essential for detecting animal welfare and health conditions (EFSA, 2011, 2012; Stärk et al., 2014) and securing traceability through checking of animal identification (EFSA, 2011). The evaluation of visual cleanliness of animals in the ante-mortem inspection has also been considered to be crucial for meat safety (EFSA, 2011, 2012, 2013a). In practice, the importance of ante-mortem inspection was shown, for instance, when signs of foot and mouth disease were first detected in a British slaughterhouse in 2001 (Scudamore, 2002). Deficiencies in ante-mortem inspection have, however, been observed in several EU countries, which substantially increase the risk of not identifying transmissible animal diseases and animal welfare problems (Alban et al., 2011). Previous investigations and reports have also highlighted that the person in charge of the task must have the appropriate skills and experience (Anonymous, 2013b; Det Norske Veritas, 2011).

After the slaughter, carcasses and offal must be subjected without delay to post-mortem inspection, where laboratory tests, whenever deemed necessary, must also be performed (EU, 2004d). Post-mortem inspection was evaluated by EFSA to be important for identifying visual faecal contamination and septicaemia in carcasses and abnormalities caused by some zoonotic agents, like mycobacteria and *Taenia solium cysticercus*, and *Trichinella* spp., by laboratory examination (EFSA, 2011, 2013a). In the post-mortem inspection, meat, offal, or carcasses not fit for consumption are condemned.

OVs have the responsibility of recording and evaluating the results of meat inspection and ensuring that these results are included in the relevant database and sent to the farmer (EU, 2004d). The utilization of meat inspection data could be improved among governments, industry, and academia (Lynch & Silva, 2013), and its use for animal health and welfare surveillance purposes should be increased (Correia-Gomes et al., 2016; EFSA, 2011; Harley et al., 2012; Stärk et al., 2014). A recent study showed that meat

inspection data yield valuable information for the surveillance of poultry health, but deficiencies in data standardization, analysis, and reporting between EU countries lower its usability (Huneau-Salaün et al., 2015).

2.7 FOOD SAFETY INSPECTIONS IN SLAUGHTERHOUSES

In slaughterhouses and adjacent cutting plants, OVs must perform food safety inspections, where at least the following areas are evaluated: a) the design and maintenance of premises and equipment, b) pre-operational, operational, and post-operational hygiene, c) personnel's hygiene, d) training in hygiene and in work procedures, e) pest control, f) water quality, g) temperature control, f) controls for food entering and leaving the establishment and any accompanying documentation, and g) implementation of SCS including HACCP-based procedures (EU, 2004d). OVs must keep record of the results of food safety inspections (EU, 2004d). Few studies have examined the impact of food safety inspections performed by the OVs in slaughterhouses. Gramenzi et al. (2013) demonstrated food safety inspections to be effective in detecting slaughterhouse non-compliance, improving the correction of non-compliance, and contributing to the hygienic quality of the products of one Italian slaughterhouse. Food safety inspection scores given by the OVs regarding the operational hygiene have been shown to be relevant and related to subsequent meat quality and safety (Habib et al., 2012; Hudson et al., 1996, Stadlmüller et al., 2017).

In Finland, an essential change in slaughterhouse control has been the implementation of a disclosure system of food safety inspection results, 'Oiva', in 2016, aiming to make food safety inspection results available to consumers, to harmonize control, and to increase transparency (Evira 2013, 2016a,c). Similar disclosure systems, with varying approaches and methods of scoring, in official control of various food businesses have been implemented in many other countries (Bavorová & Hirschauer, 2012; Bavorová et al., 2017; Fillion & Powell, 2009, 2011; Nielsen, 2006). Before the Oiva system, OVs had general instructions on how to perform food safety inspections in establishments, and all of the areas in slaughterhouse SCSs were to be inspected yearly (Evira, 2008). In Oiva, rather detailed instructions on evaluation of SCSs of food establishments have been prepared (Evira, 2017d), and Evira has also given new instructions on risk-based control (Evira, 2015a, 2017a). According to the new instructions, each part of the SCS must be inspected at least every third year, but the most essential parts for meat safety should be inspected more

frequently (Evira, 2015a, 2017a). For instance, in 2016, the most commonly inspected parts of the SCS in slaughterhouses were hygiene of premises and production and staff performance and training (Evira, 2017c). In 2105, an electronic system (Tarkkari programme) for the OVs to document food safety inspections was implemented (Evira, 2016b); before this date, documentation methods were variable.

2.8 CONTROL MEASURES AND FACTORS AFFECTING EFFICACY OF FOOD SAFETY INSPECTIONS

As mentioned above, the main responsibility of food control authorities is to verify operators' compliance with food safety legislation (EU, 2002b, 2004e; Food and Drug Administration [FDA], 2011). The primary control measure of authorities and OVs is guidance, which includes instructions, notifications, and requests. However, the authority must consider the nature of the non-compliance, the FBO's previous inspection results, and the FBO's willingness and likelihood of undertaking the required corrections when deciding which control measures to employ (EU, 2004e; Ministry of Agriculture and Forestry, 2006). If instructions, notifications, or requests are inadequate in view of the gravity of the situation or if they have been ineffective, OVs must apply administrative enforcement measures to force the FBOs to comply with the legislation. Enforcement measures that are available for use in the EU include imposition of sanitation procedures, restriction or prohibition of foodstuffs, ordering a recall or destruction of food, and suspension of operation (EU, 2004e). The OVs in Finnish slaughterhouses can apply the enforcement measures regarding food hygiene found in Section 7 (§55-§60) of the Food Act (Evira, 2012; Ministry of Agriculture and Forestry, 2006). Such control measures include: a) giving an order to correct the non-compliance, b) prohibition of the manufacturing, import, export, or placing on the market a foodstuff or its use in the food industry, c) ordering a withdrawal of a food from the market, d) seizure of a foodstuff, and e) decision on the use or disposal of a foodstuff.

Few studies have examined the control measures used by OVs and how various approaches of the OVs may affect the outcome of the inspection. Communication with slaughterhouse operators and enforcement and sanctions used by the OVs have been assessed as important in ensuring the safety of meat (Lindblad & Berking, 2013), and a consistent and proportionate approach in enforcement has been considered to have a positive effect on compliance in slaughterhouses (Pope et al., 2013). However, overly strict

enforcement may sometimes act as a barrier for compliance, especially in slaughterhouses in which staff lack understanding of how regulations are related to meat safety (Pope et al., 2013). In 2006 and 2007, the usage of enforcement measures by OVs was found to be rare in Finland (Jokela et al., 2009; Lepistö, 2008), and many OVs did not consider enforcement measures to be an efficient tool in correcting non-compliance (Jokela et al., 2009; Lepistö & Hänninen, 2011). Most OVs also felt that to increase the use of enforcement measures they would need more uniform directions, guidance, and encouragement from the central authority regarding the procedure (Lepistö & Hänninen, 2011). In 2015 and 2016, the annual total number of enforcement measures used in slaughterhouses has been reported to vary between five and six according to Evira's statistics (Evira, 2016b, 2017c), and the enforcement measures have mainly been used to correct non-compliance related to hygiene and general order of the premises (Evira, 2017c). In 2015 and 2016, OVs issued 93 (Evira, 2016b) and 56 requests (Evira, 2017c), respectively, to correct non-compliances in slaughterhouses. The close contact with the slaughterhouses has been suggested to influence the control measures used by the OVs and to increase a collaborative and educative approach in the control (Jokela et al., 2009; Lepistö, 2008). It has also been highlighted that the close contact with the slaughterhouse might cause the OVs to feel pressure from the slaughterhouse to provide better inspection results (Pinillos & Jukes, 2008).

Although studies in slaughterhouses are rare, food safety inspections have been examined in, for instance, local food control units and restaurants and other food establishments. For the efficacy of food safety inspections, a focused approach of the officials with clear objectives, fixed frequency of inspections (Fong et al., 2017; Gramenzi et al., 2013), and imposition of exact time limits for the FBOs to correct a non-compliance (Läikkö-Roto et al., 2015) have been demonstrated to be important. An educative and collaborative approach of the food safety officials has also been assessed favourably (Buckley, 2015; Fairman & Yapp, 2005; Nevas et al., 2013; Newbold et al., 2008; Reske et al., 2007; Yapp & Fairman, 2006). Interpersonal skills of the food safety inspector, including good communication skills, patience, empathy, respect, and consideration, should be emphasized during inspections (Buckley, 2016) and control measures should be properly explained (Laikkö-Roto & Nevas, 2014b; Nevas et al., 2013).

Although many studies stress an educative approach, enforcement measures have been demonstrated to be an effective tool in making FBOs correct their food safety violations (Kettunen et al., 2015). Lowering the threshold of initiating an enforcement process especially towards those FBOs

repeatedly violating food safety regulations seems beneficial (Kettunen et al., 2018). Enforcement measures can be perceived as heavy, demanding, and time-consuming (Jokela et al., 2009; Lepistö & Hänninen, 2011). Lack of guidance and routine and poorly defined practices in local food control units appear to decrease the use of enforcement measures and the consistency of employing these measures (Kettunen et al., 2017b). Pro-forma templates for the use of enforcement measures have been noted to facilitate use of these measures (Kettunen et al., 2017b). The officials in local food control units have also predicted that the national evaluation guidelines of the Oiva system will improve the consistency of using these measures (Kettunen et al., 2017b).

Variation and inconsistency in control approaches and measures between food safety officials and between local food control units have been demonstrated in numerous studies (Ho, 2012; Hutter & Amodu, 2009; Kettunen et al., 2017a, 2018; Lee-Woolf et al., 2015; Läikkö-Roto et al., 2015; Mascini, & Wijk, 2009; Pope et al., 2013; Tähkäpää, 2016; Tähkäpää et al., 2008). The food safety legislation frequently uses words such as "sufficient" and "adequate" (Riedl, & Riedl, 2008), which are open to interpretation and may cause variation in regulatory outcomes (Tähkäpää et al., 2008). The OVs in Finnish small-scale slaughterhouses have considered guidance on the interpretation of food safety legislation as important for the quality of inspections (Kotisalo et al., 2015). Guidance provided to the official control staff has been deemed to be particularly important in increasing the uniformity of food safety inspections (Kettunen et al., 2018; Lee-Woolf et al., 2015; Läikkö-Roto et al., 2015), together with regular retraining and standardization among inspection evaluations (Jones et al., 2004). Disclosure systems have also been shown to contribute to the uniformity of food safety inspections (Thompson et al., 2005; Toronto Public Health, 2002) and to compliance (Anonymous, 2003; Bavorová et al., 2017; Choi & Scharff, 2017; Waters et al., 2013). The use of checklists, templates for inspection reports (Läikkö-Roto et al., 2015), and peer-reviewing and co-inspections among inspecting food safety officials (Ho, 2017) have also been demonstrated to increase the uniformity of controls.

2.9 DEFICIENCIES OBSERVED IN OFFICIAL CONTROL OF SLAUGHTERHOUSES

2.9.1 DEFICIENCIES IN MEAT INSPECTION

Information on the deficiencies in meat inspection is largely based on audit reports prepared by the FVO or other audit bodies. In addition, a few scientific studies outside the EU and reports of outbreak investigations have presented deficiencies.

The FVO has observed deficiencies in OVs' inspection of FCI and incomplete FCI in multiple EU countries (Alban et al., 2011). Non-conformities have also been noted in the task distribution of ante-mortem inspection in some European countries, as the ante-mortem inspection has not been performed by the OV in poultry slaughterhouses (Anonymous, 2013c; EFTA Surveillance Authority, 2014) or in red meat slaughterhouses (Alban et al., 2011; FVO, 2002, 2013). Ante-mortem inspection has also been observed in general as insufficient in some EU countries (Alban et al., 2011), and deficiencies in the documentation of the inspection have been observed (Food Safety Authority of Ireland, 2012).

In post-mortem inspection, a lack of supervision of the OAs by the OVs has emerged (EFTA Surveillance Authority, 2014; FVO, 2002). According to audit reports, it appears fairly common that all inspection procedures in the post-mortem inspection are not performed entirely according to the legislation and especially deficiencies in the inspection of intestines have been observed in many European countries (Alban et al., 2011; EFTA Surveillance Authority, 2012). Insufficient poultry post-mortem inspection has also been identified in some EU countries (EC, 2013) and in South Africa (Govender, 2012).

2.9.2 DEFICIENCIES IN FOOD SAFETY INSPECTIONS

Information on deficiencies in food safety inspections performed by OVs is scarce, but especially insufficient enforcement has been reported (Table 1). Insufficient enforcement regarding hygiene may lead to serious consequences as in Wales in 2005, when 157 consumers were infected with *E. coli* O:157 due to the slaughterhouse's hygiene problems that had not been adressed by the OV (Anonymous, 2006b; Pennington, 2009).

Table 1. *Deficiencies in food safety inspections performed by the official veterinarians (OVs) in slaughterhouses (SHs) reported in the literature.*

Deficiency	Country/countries	Reference
Insufficient verification of sanitation	USA	Anonymous, 2013c
Insufficient verification of the implementation of SCS[a]	Canada	Lewis et al., 2013
Insufficient identification of SHs' non-compliance	EU countries	Alban et al., 2011
Insufficient follow-up of correction of non-compliance	EU countries	FVO, 2013
Insufficient enforcement	Canada EU countries Finland UK	Lewis et al., 2013 Alban et al., 2011; EC, 2013 Lepistö, 2008 Pennington, 2009
Inconsistency in interpretation of legislation between OVs	Canada EU countries	Charlebois & Summan, 2014 FVO, 2002

[a]Self-checking system

2.10 SELF-CHECKING SYSTEMS AND THEIR IMPLEMENTATION IN MEAT PLANTS

2.10.1 CONTENT AND SIGNIFICANCE OF SELF-CHECKING SYSTEMS

Every slaughterhouse in the EU is obligated to implement a SCS based on basic hygiene features, also referred to as prerequisite programmes, and the principles of the HACCP (EU, 2004b,c). FBOs must have a self-checking plan in which their SCS is described (EU, 2004b). Prerequisite programmes, including good manufacturing practices, good hygiene practices, and standard operating procedures in sanitation, must be implemented before HACCP in order for HACCP to work (Rahkio, 2010). Important examples of prerequisite programmes in slaughterhouses include: a) checking of FCI, b) design and maintenance of premises and equipment, c) preoperational, operational, and postoperational hygiene, d) personal hygiene, e) training in hygiene and work procedures, f) pest control, g) water quality, and h) temperature control (Rahkio, 2010).

HACCP is a control system that aims to identify hazards and perform intervention strategies to decrease the likelihood of these hazards occurring. The system includes hazard analysis and defining of critical control points where controls can be applied to eliminate or reduce particular hazards

(Pearce et al., 2004). HACCP also entails establishing procedures for verification that include supplementary tests and procedures to confirm that the HACCP system is working properly as well as the documentation of these procedures (Rahkio, 2010). Critical control points in slaughterhouses may include, for instance, zero tolerance for faecal contamination and specific cooling time and temperature of the carcass after slaughter (Savage, 2014).

HACCP became a universally recognized method for food safety assurance after 1993, when the FAO/WHO Codex Alimentarius Commission adopted the application of the principles (Luning et al., 2015). HACCP is obligatory in meat processing plants in the EU as well as in the USA (Food Safety and Inspection Service [FSIS], 1996) and Australia (Desmarchelier et al., 2007). Previous research has shown a decline in meatborne outbreaks in the past few decades and decreased pathogen contamination in meat processing, suggesting that the implementation of HACCP has been an important contributing factor (Gormley et al., 2011; Hong et al., 2008; Wilhelm et al., 2011; Williams & Ebel, 2012). The implementation of HACCP has been assessed to lead to better microbiological quality of meat in slaughterhouses (Tsola et al., 2008). The meat industry has also seen multiple benefits in implementation of HACCP such as improved hygiene management ability, decreased rejection of products, and increased customer satisfaction, plant image, and accessibility to international markets (Baek et al., 2012; Khatri & Collins, 2007; Maldonado-Siman et al., 2014a,b; Tomašević et al., 2013). In Finland, slaughterhouses' views on SCS have not been reported, but other food manufacturing companies' attitudes towards SCSs and HACCP have been found to be highly positive and assessed to contribute to product safety and quality (Hielm et al., 2006).

2.10.2 IMPORTANCE OF HYGIENE AND TEMPERATURE CONTROL IN SLAUGHTERHOUSES

Slaughtered animals' faeces and hides contain many important pathogenic bacteria such as *E. coli* (Buncic et al., 2014; Desmarchelier et al., 2007; Eriksson et al., 2005; Wells et al., 1991), *Salmonella* (Baptista et al., 2010; Bolton et al., 2002; Buncic et al., 2014; Desmarchelier et al., 2007; Duggan et al., 2010; Piras et al., 2014), *Yersinia enterocolitica* (Laukkanen-Ninios et al., 2014), *Campylobacter* (Hansson et al., 2010), and *Staphylococcus aureus* (Desmarchelier et al., 2007; Hennekinne et al., 2011). These pathogenic bacteria can contaminate meat either directly by faeces and dirty hides (Bell, 1997; Hadley et al., 1997) or indirectly via the utensils, hands, and clothing of slaughterhouse staff or meat inspection personnel (Davies et al., 2000; FSA,

2016), aerosols (Rahkio & Korkeala, 1997), and water droplets (Davies et al., 2000; FSA, 2016). Therefore, slaughter hygiene has been evaluated to be a tremendously important factor for meat safety (Codex Alimentarius Commission, 2005; Nørrung & Buncic, 2008; WHO, 2006), and, for instance, the hygienic removal of hide and general management of microbial risks and operational hygiene within the slaughterhouse have been assessed as important for control of important pathogens (Baer et al., 2013; Baptista et al., 2010; Berends et al., 1997; EFSA, 2011; Guergueb et al., 2014; Habib, et al., 2012; Hudson et al., 1996; Lindblad & Berking, 2013; Osés et al., 2012; Rahkio & Korkeala, 1996). Slaughterhouse process hygiene has been assessed as even more relevant for ensuring biological safety of beef carcasses than meat inspection, although both are necessary to control certain hazards (Blagojevic, & Antic, 2014; Blagojevic et al., 2012). As major foodborne pathogens have been frequently detected in meat and meat products, they have been the focus of regulatory actions and surveillance programmes in recent years (Baptista et al., 2010; Desmarchelier et al., 2007; Gill & Gill, 2010; Hussein & Bollinger, 2005; Muth et al., 2009; Wegener, 2010). As a part of the SCS, in order to ensure the hygiene of the meat and the process, slaughterhouses must take regular microbial samples of the carcasses and analyse them, for instance, for *Salmonella* and *Enterobacteriaceae* (EU, 2005a).

Another important principle and basic requirement in the EU food safety legislation is carcass-chilling and proper storage temperatures in meat plants (EU, 2004d). The chemical composition of meat, which is rich in proteins, lipids, and water, makes meat a favourable substrate for the growth of micro-organisms, and therefore, proper storage temperatures are important for the quality and safety of meat (Borch et al., 1996; Nastasijević et al., 2017; Pacholewicz et al., 2016).

2.10.3 FOOD BUSINESS OPERATOR-RELATED FACTORS AFFECTING COMPLIANCE

A thorough self-checking plan does not automatically ensure meat safety if it is not sufficiently implemented (Weatherill, 2009). For instance in the UK, the SCSs in slaughterhouses appeared to be less effectively implemented than in other meat plants (Kotsanopoulos & Arvanitoyannis, 2017a). The compliance in slaughterhouses and meat plants between poultry processing and red meat processing has also been compared. According to Kotsanopoulos and Arvanitoyannis (2017a), plants processing red meat were more compliant than plants processing poultry, whereas other studies have shown the opposite results (BRC Global Standards, 2015; Pinillos & Jukes, 2008). Also non-

compliance in smaller slaughterhouses and meat plants has been shown to be more common than in larger plants (Govender, 2012; Kotsanopoulos & Arvanitoyannis, 2017a; Xiong et al., 2017).

One important factor affecting the implementation of the SCS is the understanding and knowledge of the employees regarding the SCS (Weatherill, 2009). The need for education and training of slaughterhouse employees on SCSs (Lindblad & Berking, 2013) and hygiene (Gomes-Neves et al., 2011; Nel et al., 2004) has been previously highlighted in securing good hygiene practices. Food hygiene knowledge is associated with better food safety in restaurants as well (Läikkö-Roto & Nevas, 2014b).

Studies have also shown that although food handlers have knowledge they do not necessarily put it into practice (Abdul-Mutalib et al., 2012; Ansari-Lari et al., 2010; Clayton et al., 2002; Pacholewicz et al., 2016). Therefore, FBOs' and their employees' commitment and attitudes towards food safety have been emphasized lately and have been considered to have a strong impact on compliance (Ball et al., 2009, 2010; Fotopoulos et al., 2009; Läikkö-Roto & Nevas, 2014b; Mensah & Julien, 2011; Ramalho et al., 2015). The concept of food safety culture/climate has received growing interest (De Boeck et al., 2016; Griffith et al., 2010a,b; Powell, Jacob, & Chapman, 2011; Wright et al., 2012), and tools to assess it have been developed (De Boeck et al., 2015; Wright et al., 2012). Food safety culture is a combination of personnel's values, attitudes, competencies, and practices that define operators' commitment to the implementation of SCSs (Yinnas, 2009). Poor food safety culture has been assessed to contribute to serious foodborne outbreaks (Powell et al., 2011; Wright et al., 2012), whereas good food safety culture contributes to better microbiological hygiene of meat (De Boeck et al., 2016) and more compliant and hygienic procedures in evisceration in slaughterhouses (Pacholewicz et al., 2016).

Abundant previous research has demonstrated that the smaller food businesses have more difficulties in implementing their SCSs than larger businesses (Conter et al., 2007; Fielding et al., 2005; Kök, 2009; Losito et al., 2011; Walker et al., 2003). Smaller food businesses have been reported to have challenges affecting their compliance such as lack of time, resources, money, and food safety knowledge and expertise (Fairman & Yapp, 2004, 2005; Luning et al., 2015; Mensah & Julien, 2011; Taylor, 2001; Violaris et al., 2008; Walker et al., 2003; Wilcock, et al., 2011; Yapp & Fairman, 2006). Due to these challenges, smaller food businesses have been suggested to require more tailored support and guidance from the food safety officials in relation to SCS (FSA, 2013; Luning et al., 2015; Pope et al., 2013). The role of the food safety official may also become emphasized in ensuring the compliance because the

smaller food businesses do not necessarily have the skills to observe and understand the hazards within their production (Fairman & Yapp, 2004; Pope et al., 2013). In these cases, the motivation to correct a non-compliance does not come from within, but relies on the enforcer (Fairman & Yapp, 2004). A distrust of the food safety regulation or the food safety official has also been shown to correlate with non-compliance in small- and medium-sized food businesses (Yapp & Fairman, 2006).

Like other smaller food businesses, also the small-scale slaughterhouses are known to have a shortage of skilled employees (Charlebois & Summan, 2014; Lewis & Peters, 2012, Local Food Research Center, 2012; Summan, 2013) and difficulties with costs in general (Charlebois & Summan, 2014, Summan, 2013). A recent study investigated the costs of developing SCSs in slaughterhouses in the USA and they ranged from approximately $6000 to $87 000, depending on the system and on the plant (Viator et al., 2017). Many smaller slaughterhouses and meat plants have considered the costs spent on food safety and quality systems as a prohibitive burden, whereas many larger businesses viewed them as a beneficial investment (Jayasinghe-Mudalige & Henson, 2007). Lack of resources in slaughterhouses has also been found to be linked to resistance in making corrections demanded by the OVs (Pope et al., 2013).

2.10.4 NON-COMPLIANCE IN SLAUGHTERHOUSES AND OTHER MEAT PLANTS

Slaughterhouses have been reported to have deficiencies, especially related to hygiene and implementation of SCSs, including HACCP (Table 2). Also the self-checking records have been insufficient or totally lacking in some slaughterhouses (Govender, 2012; Govender & Genis, 2010; Kotsanopoulos & Arvanitoyannis, 2017a), and, for instance, OVs in British slaughterhouses have speculated that the documented procedures of HACCP do not always reflect food safety behaviours of slaughterhouse employees (Pope et al., 2013).

Deficiencies in slaughterhouses have also been associated with some serious meatborne outbreaks. In the USA, poor overall hygiene in slaughterhouses and in dehiding has been suggested to lead to more than 700 individuals becoming infected with *E. coli* O157:H7, including four deaths (Tuttle et al., 1999). Outbreak investigations behind 18 cases of *E. coli* O157:H7 illness in Canada revealed that the meat in question came from a slaughterhouse with deficiencies in slaughter hygiene, sanitation, maintenance, analysis of self-checking samples, and monitoring activities of SCS (Lewis et al., 2013). In Norway, a large *E. coli* O103:H25 outbreak with 18

cases and one death revealed deficiencies in slaughter hygiene (Anonymous, 2006a).

According to Evira's statistics, the most common areas receiving poor grades in the food safety inspections of slaughterhouses have been related to production hygiene (Evira, 2017c). During Oiva inspections in 2016, altogether 81.6% of the slaughterhouses, including small-scale slaughterhouses, and adjacent meat plants received grades A or B (excellent or good) and 18.4% grades C or D (to be corrected or poor) (Evira, 2017c).

In meat plants, deficiencies have been reported especially in sanitation, prevention of cross-contamination, and maintenance (Table 3). Also difficulties in the design of HACCP and self-checking records have been observed (Table 3). The source of a large outbreak of *Listeria monocytogenes* with more than 970 cases resulting in a high proportion of deaths (183, i.e. 19%, by 28.3.2018) was traced to a meat processing plant in South Africa with insufficient sanitation (ECDC, 2018a,b; Motsoaledi, 2018).

Table 2. *Deficiencies in slaughterhouse self-checking systems (SCSs) reported in the literature. Self-checking related to animal welfare is not included.*

Deficient area	Country/countries	Reference
Hygiene		
Slaughter hygiene	EU countries[a]	Alban et al., 2011; FVO, 2002, 2010
	Finland	Haltiala, 2013
	Italy	Mazzettte et al., 2015
	Norway	Anonymous, 2006a
Hygiene in dehiding	EU countries[a]	FVO, 2013
	USA	Tuttle et al., 1999
Hygienic working methods	Canada	Lewis et al., 2013
	EU countries	FVO, 2002, 2013; EC, 2013
	Kenya	Cook et al., 2017
	Netherlands	Pacholewicz et al., 2016
	USA	Tuttle et al., 1999
	Zimbabwe	Masanganise et al., 2013;
Personal hygiene	China	Xiong et al., 2017
	Kenya	Cook et al., 2017
Storage hygiene	UK	Kotsanopoulos & Arvanitoyannis, 2017a
Sanitation	EU countries[a]	FVO, 2010
	Canada	Lewis et al., 2013
	China	Xiong et al., 2017
	Italy	Gramenzi et al., 2013
	South Africa	Govender, 2012; Govender & Genis, 2010
	Zimbabwe	Masanganise et al., 2013
Prevention and control of meat contamination	China	Xiong et al., 2017
	France	Bonnaud & Coppalle, 2013
	EU countries[a]	FVO, 2010
	Netherlands	Pacholewicz et al., 2016

Table 2. *Continues.*

Deficient area	Country/countries	Reference
Prevention and control of meat contamination	UK	Kotsanopoulos & Arvanitoyannis, 2017a
	Zimbabwe	Masanganise et al., 2013
Sterilizing utensils	EU countries[a]	FVO, 2013
	Netherlands	Pacholewicz et al., 2016
	Zimbabwe	Masanganise et al., 2013
Maintenance	Canada	Lewis et al., 2013
	Finland	Haltiala, 2013
	France	Bonnaud & Coppalle, 2013
	Italy	Gramenzi et al., 2013
	Kenya	Cook et al., 2017
	EU countries[a]	FVO, 2010
	South Africa	Govender, 2012; Govender & Genis, 2010
	Zimbabwe	Masanganise et al., 2013
Waste management	France	Bonnaud & Coppalle, 2013
	Zimbabwe	Masanganise et al., 2013
Sampling and sample analysis	Canada	Lewis et al., 2013
	Finland	Haltiala, 2013
Pest control	China	Xiong et al., 2017
	South Africa	Govender & Genis, 2010
Implementation, updating and verification of SCS		
Implementation of SCS including HACCP[b]	EU countries[a]	Alban et al., 2011; EC, 2013; FVO, 2013
	Finland	Haltiala, 2013
	South Africa	Govender & Genis, 2010
	UK	Kotsanopoulos & Arvanitoyannis, 2017a
Updating of self-checking plan	Canada	Lewis et al., 2013
Procedures for verification of SCS	Canada	Lewis et al., 2013
	China	Xiong et al., 2017

Table 2. *Continues.*

Deficient area	Country/countries	Reference
Self-checking records	South Africa UK	Govender, 2012; Govender & Genis, 2010 Kotsanopoulos & Arvanitoyannis, 2017a
Other areas of SCS		
Training of the employees	Italy Kenya	Gramenzi et al., 2013 Cook et al., 2017
Management of by-products	Finland Italy USA	Haltiala, 2013 Gramenzi et al., 2013 Anonymous, 2013c
Labelling	Zimbabwe	Masanganise et al., 2013

[a]Reference does not specify countries.

[b]HACCP=Hazard Analysis and Critical Control Points

Table 3. *Deficiencies in meat plant self-checking systems (SCSs) reported in the literature.*

Deficient area	Country/countries	Reference
Hygiene		
Hygienic working methods	EU countries	FVO, 2013*
	UK	Anonymous, 2006c; Pennigton, 2009*; FSA, 2018*
Sanitation	Canada	FSIS, 2017*; Weatherill, 2009
	EU countries	FVO, 2010
	Iceland	EFTA Surveillance Authority, 2014;
	South Africa	Motsoaledi, 2018
	UK	Anonymous, 2006c; Pennigton, 2009*
	USA	Anonymous, 2013c*; Mead et al., 2006; Tuttle et al., 1999
Prevention of cross-contamination	Finland	Kotisalo & Nevas, 2009*; Tähkäpää et al., 2009*
	Iceland	EFTA Surveillance Authority, 2012*, 2014
	UK	Anonymous, 2006c; Kotsanopoulos & Arvanitoyannis, 2017a*; Pennigton, 2009
Sterilizing utensils	Iceland	EFTA Surveillance Authority, 2012*, 2014
Maintenance	Canada	Weatherill, 2009
	Finland	Kotisalo & Nevas, 2009*; Tähkäpää et al., 2009*
	Iceland	EFTA Surveillance Authority, 2012*, 2014
	EU countries	FVO, 2010*
	EU and non-EU countries	BRC Global Standards, 2015*
	UK	Anonymous, 2006c; Pennigton, 2009
Sampling and sample analysis	UK	FSA, 2018*
Pest control	Iceland	EFTA Surveillance Authority, 2012*

Table 3. *Continues.*

Deficient area	Country/countries	Reference
Implementation and verification of SCS		
Design of HACCP	Canada Finland Iceland UK USA	Weatherill, 2009 Tähkäpää et al., 2009* EFTA Surveillance Authority, 2012*, 2014 Anonymous, 2006c; Pennigton, 2009; Anonymous, 2013c*
Implementation of SCS	Finland Iceland	Tähkäpää et al., 2009* EFTA Surveillance Authority, 2012*
Procedures for verification of SCS	Canada	FSIS, 2017*
Self-checking records	Canada EU and non-EU countries UK	FSIS, 2017* BRC Global Standards, 2015*; Anonymous, 2006c; Kotsanopoulos & Arvanitoyannis, 2017a*; Pennigton, 2009
Other areas of SCS		
Insufficient training of employees	UK; UK; UK	Anonymous, 2006c; Kotsanopoulos & Arvanitoyannis, 2017a*; Pennigton, 2009
Labelling	Finland	Tähkäpää et al., 2009*
Traceability	UK	FSA, 2018*

*Reference might also represent slaughterhouse deficiencies but they are impossible to separate.

2.11 AUDITING AS A TOOL FOR IMPROVING OFFICIAL CONTROL

The roots of audits derive from financial accounting, but audits have since been adopted by variable private and public organizations (Johnsen et al., 2001; Junttila, 2014). Multiple different types of audits exist, as the clients, auditors, criteria, and objectives of the audits can vary (Junttila, 2014). Internal audits are, for instance, performed by auditors within the organization, whereas external audits are performed by an outside entity (Powell et al., 2013). Common to all audits is that they aim to evaluate whether the auditee is in compliance with audit criteria that can comprise legislation, standards, requirements, procedures, or policies (Junttila, 2014).

According to EC Regulation No. 882/2004, an audit is "a systematic and independent examination to determine whether activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives" (EU, 2004e). Competent authorities in each member state are obligated to perform either internal audits or have external audits carried out to ensure that the official controls are in accordance with the legislation (EU, 2004e). Each member state should have sufficient resources for effective audits, and audits should be transparent, clearly reported, and the outcome followed up (EC, 2006). Audits should also be performed by competent and independent auditors, who should not be responsible for the activities that they audit (EC, 2006). The Finnish Food Safety Authority Evira has performed internal audits in slaughterhouses to evaluate meat and food safety inspections. The auditors have been involved with the guiding and organizing of official control in slaughterhouses. Since this study was performed, Evira has aimed to increase the independence of their audits (Evira, 2011, 2014a). For instance, chain audits, which concentrate on a specific control sector as a whole and whose auditors come from different departments within the central authority, have been adopted (Evira, 2014a, 2017b). Some EU countries apparently have too few resources, and therefore, the frequency of the audits has decreased (EC, 2013), and also deficiencies in the reporting of the outcome and the follow-up of non-conformities of the audits have been observed (EC, 2013; FVO, 2002).

The forementioned audits are examples of performance audits that are assessments of government actions or organizations and are related to one or more of the following aspects: performance, efficiency, effectiveness, and economy (Bawole & Ibrahim, 2016; International Organization of Supreme

Audit Institutions, 2003). Audits have been considered to be a good instrument to improve the functionality of organizations (Bawole & Ibrahim, 2016; Daujotaitė & Mačerinskienė, 2008; Junttila, 2014; Morin, 2004). However, the effects of the audits performed by the central authorities of the EU member states have not, to the author's knowledge, been investigated in relation to slaughterhouse control. Läikkö-Roto and Nevas (2014a) have studied auditing in municipal food control of Finland, concluding that the audits were considered more useful by the regional officials acting as auditors than by the auditees (Läikkö-Roto & Nevas, 2014a). In the same study, auditors' experience in practice in food control was assessed as insufficient by the municipal officials, and the results of the audits were inadequately utilized in developing the audits according to the auditors (Läikkö-Roto & Nevas, 2014a).

Several factors have been considered to influence the impact of audits such as the knowledge and expertise of the auditors (Dittenhofer, 2001; Powell et al., 2013), auditees' perceptions of the usefulness of the audits (Morin, 2001, 2004), credibility of the auditors in the eyes of auditees (Morin, 2001, 2004), co-operative rather than confrontational attitude of the auditors, and timing of the audit (Morin, 2001). If the observations and recommendations of the auditors are perceived as irrelevant to improvement by the auditees, it may cause resistance (Leeuw, 2011; Morin, 2004; Weets, 2008).

3 AIMS OF THE STUDY

The aim of this study was to examine the quality of official control in Finnish slaughterhouses and to find ways to improve it. Factors affecting the quality of meat inspection and food safety inspection were evaluated from meat inspection personnel's, slaughterhouse operators', and central officials' standpoints. Specific objectives were as follows:

1) To investigate the prerequisites for high-quality official control in slaughterhouses and identify ways to enhance these prerequisites (I, II, III).
2) To investigate non-compliance of slaughterhouses' SCSs and assess the need for improvement (III).
3) To examine efficacy of control measures used by OVs and deficiencies in official control of slaughterhouses (III, IV).
4) To assess the necessity and benefits of the internal audits performed by the central authority in slaughterhouses and the need for improvement of audits (IV).

4 MATERIALS AND METHODS

The study was performed to investigate the quality of official control in Finnish red meat and poultry slaughterhouses in operation during 2009-2015. Small-scale slaughterhouses that processed under 20 livestock units (one bovine or five pigs) per week, under 1000 livestock units per year, or under 150 000 birds per year were excluded (Ministry of Agriculture and Forestry, 2011, 2014). During the study period the number of operating red meat and poultry slaughterhouses was 13-15 and 4, respectively.

4.1 QUESTIONNAIRES (I, II, III)

Altogether three questionnaires were sent during the study period. The questionnaires were conducted electronically by E-lomake® (Eduix/Delta Piktori Oy, Helsinki, Finland), with the exception of OAs who received paper versions. One reminder was sent after each of the questionnaires. All of the questionnaires included Likert-scale questions, other multiple-choice questions, and open-ended questions.

Two of the questionnaires (I, II) were sent to all full-time OVs and OAs, slaughterhouse representatives (slaughterhouse directors, quality/production managers, or foremen), and officials in the control department of Evira who were responsible for guiding and organizing official control in slaughterhouses (Table 4). The first of these questionnaires was sent in November and December 2013, and it evaluated views on the importance and functionality of meat inspection tasks and their distribution (I). Respondents were asked to evaluate the importance of FCI, ante-mortem and post-mortem inspections for meat quality and safety, animal welfare, and prevention of transmissible animal diseases. The questionnaire also collected opinions on the functionality of the distribution of meat inspection tasks and on possible needs for change in the task distribution. The second questionnaire (II) that was sent in November 2014 inquired about a) meat inspection personnel resources, b) sufficiency of these resources, c) skills of OAs, d) meat inspection personnel's participation in further training, e) evaluation of OAs' post-mortem inspection, f) meat inspection personnel's independence from the slaughterhouse in meat inspection, and g) quality of guidance given to the meat inspection personnel.

The third questionnaire (III) was sent to the chief OVs (n = 17) of each slaughterhouse in May 2014. In the questionnaire, the chief OVs were asked

to report in which part of the SCS they had observed non-compliance during the previous year and how frequent and how severe these cases of non-compliance had been in relation to meat safety. The control measures used by the OVs were enquired about and statements regarding SCS, official control, professional skills of OVs, and guidance given by the central authority to the OVs in food safety inspections were included. The questionnaire also collected information on OVs' views on how well the self-checking plan complied with the food safety legislation and how important the slaughterhouse operator considered the self-checking plan.

4.2 INTERNAL AUDIT REPORTS (IV)

We analysed in total 60 internal audit reports of slaughterhouse control, of which 38 concerned audits of meat inspection (performed by the meat inspection unit of Evira in 19 slaughterhouses) and 22 audits of food safety inspections (performed by the food hygiene unit of Evira in 17 slaughterhouses). The meat inspection unit begun their audits one year before the food hygiene unit, and thus, the reports were from the periods 2009-2013 and 2010-2013, respectively. From the reports, non-conformities (in meat and food safety inspections) and targets for development (only in food safety inspections) were analysed. Non-conformities were defined as observations not complying with the legislation or Evira's instructions, and targets for development as observations that when corrected would improve the efficacy of food safety inspections. The correction of non-conformities was evaluated based on later audits or on the reports that OVs were obligated to send regarding the correction of observed non-conformities. We were unable to receive one audit report and two reports on corrective measures because they had not been filed in a uniform way by the central authority.

4.3 INTERVIEWS AND THEIR QUALITATIVE ANALYSIS (IV)

To assess the necessity, benefits, and needs for improvement of the internal audits, a semi-structured interview of the chief OVs and auditors was conducted in May–June 2015. This interview method included a set of questions, asked in systematic order, and the researcher was allowed to pose probing questions (Fylan, 2005). The interview included structured questions, including questions with a ten-grade scale (only minimum and maximum were given verbally) on how necessary and how beneficial internal audits were. Also

open-ended questions were included. The researcher conducted the interviews and wrote the answers down simultaneously. Chief OVs' interviews were conducted by Microsoft Lync 2013 or by telephone, and the auditors were interviewed in person.

Inductive content analysis was used to identify thematic categories from the interviews (Braun & Clarke, 2006; Elo & Kyngäs, 2008; Vaismoradi et al., 2013) in relation to the following questions: a) what are the benefits gained from the audits and b) how should the audits be improved in the future. The responses were initially coded, and related codes were then merged into subcategories and their frequency calculated. Subcategories were grouped into final categories with the help of discussion with the other three authors.

4.4 STATISTICAL ANALYSIS (I, II, III, IV)

Statistical analysis of the questionnaires, internal audit reports, and the interviews was performed with SPSS 21.0 (SPSS IMB, Armonk, NY, USA). The data were not normally distributed, and thus, we used non-parametric statistical tests. Two-tailed p-values of less than 0.05 were considered statistically significant.

4.4.1 STATISTICAL ANALYSIS OF THE QUESTIONNAIRES (I, II, III)

In the analysis of the questionnaires, the 'do not know' answers were converted to missing. The significance of the difference between respondent groups' answers was analysed by Kruskal-Wallis test. In cases comparing only two different groups, Mann-Whitney U-test, with ordinal variables, or Fisher's exact test, with categorical variables, was used. Groups that were compared were a) respondent groups (I, II, III), b) red meat versus poultry slaughterhouses (I, II, III), and c) smaller versus larger slaughterhouses (II, III). The size of the slaughterhouse was determined either by the number of OVs in the slaughterhouse (III) or by the number of slaughtered animals per week (II). Slaughterhouses that had one or two OVs or slaughtered under 1000 red meat animals or under 200 000 birds per week were categorized as smaller slaughterhouses. Slaughterhouses having three to six OVs or a slaughtering capacity of more than 1000 red meat animals or more than 200 000 birds per week were categorized as larger slaughterhouses.

4.4.2 STATISTICAL ANALYSIS OF THE INTERNAL AUDIT REPORTS (IV)

We analysed non-conformities and targets for development (together referred to as deficiencies) in each slaughterhouse, between red meat and poultry slaughterhouses, and between slaughterhouses of different sizes. Slaughterhouses were divided in smaller and larger slaughterhouses based on the number of slaughtered animals per week, the limits being presented in Section 4.4.1. Fisher's exact test was used to evaluate statistical differences between slaughterhouses in the occurrence of non-conformities and targets for development in each area of official control. The difference between slaughterhouses' numbers of areas with non-conformities and targets for development were analysed with Mann-Whitney U-test.

4.4.3 STATISTICAL ANALYSIS OF THE INTERVIEWS (IV)

The responses over a ten-grade scale were analysed statistically. Differences between OVs' and auditors' responses were analysed by Mann-Whitney U-test. Wilcoxon's signed rank test was used to compare OVs' answers regarding the necessity of internal audits of meat inspection and food safety inspection.

5 RESULTS

5.1 QUESTIONNAIRE RESPONSE RATES AND RESPONDENTS (I, II, III)

The response rate to the questionnaire investigating functionality of meat inspection tasks and their distribution together with the perceived importance of meat inspection tasks (I) was 83% (Table 4). The questionnaire inquiring about the sufficiency, independence, meat inspection skills, further training, and guidance of meat inspection personnel (II) had a total response rate of 59% (Table 4). This questionnaire was answered by 14 chief OVs (10 red meat and 4 poultry), and all of the respondents could also be divided into different slaughterhouses based on the basic information given (on number of OVs, OAs, and slaughtered animals per week in the slaughterhouse).

Table 4. *Respondent groups and response rates in questionnaires regarding the functionality of meat inspection task distribution (I) and sufficiency, independence, meat inspection skills, further training, and guidance of meat inspection personnel (II).*

Respondent group	Response rate % (n/N[a]) (I)	Response rate % (n/N[a]) (II)
Red meat official veterinarians[b]	78 (25/32)	56 (19/34)
Poultry official veterinarians	100 (9/9)	55 (6/11)
Red meat official auxiliaries	75 (36/48)	50 (24/48)
Poultry official auxiliaries	93 (53/57)	61 (38/62)
Representatives of red meat SHs[c]	87 (20/23)	89 (16/18)
Representatives of poultry SHs	80 (8/10)	38 (3/8)
Officials in control department[d]	69 (11/16)	59 (10/17)
Total	83 (162/195)	59 (116/198)

[a]Number of respondents/number of official veterinarians, official auxiliaries, slaughterhouse (SH) representatives, or officials from the control department to whom the survey was sent
[b]Official veterinarians working in SHs for pigs, bovines, horses, sheep, and/or goats
[c]SH directors, foremen, or quality and production managers familiar with meat inspection issues in each SH
[d]Officials in the control department of Evira who guided and organized official control in SHs at the central level

The questionnaire examining non-compliance in slaughterhouses and control measures used by the OVs (III) had a total response rate of 76%, as 10/13 chief OVs from red meat slaughterhouses and 3/4 chief OVs in poultry slaughterhouses answered the questionnaire. Based on the frequency of non-compliance, slaughterhouses were divided into two distinctly different groups: a) slaughterhouses (n = 3) where non-compliance in six or more parts of the SCS was often or always observed when inspected (slaughterhouses with high

frequencies of non-compliance) and b) slaughterhouses (n = 10) where fewer than four cases of non-compliance were observed often or always (slaughterhouses with low frequencies of non-compliance). The slaughterhouses were also divided into two groups by the severity of non-compliance: a) slaughterhouses (n = 6) where somewhat severe or severe non-compliance was observed in six or more parts of the SCS (slaughterhouses with high severity of non-compliance) and b) slaughterhouses (n = 7) where severe non-compliance was observed in fewer than six parts of the SCS (slaughterhouses with low severity of non-compliance). The three smaller red meat slaughterhouses where the OV observed most cases of non-compliance in various parts of the SCS were also slaughterhouses with high frequencies and severity of non-compliance. In addition, two larger red meat slaughterhouses and one smaller poultry slaughterhouse had a high severity of non-compliance.

5.2 PREREQUISITES FOR HIGH-QUALITY OFFICIAL CONTROL IN SLAUGHTERHOUSES (I, II, III)

5.2.1 FUNCTIONALITY OF MEAT INSPECTION TASKS AND THEIR DISTRIBUTION (I)

According to the results, OVs in poultry slaughterhouses did not receive assistance from the OAs in ante-mortem inspection, and the inspection functioned well or very well according to all OVs and slaughterhouse representatives. In red meat slaughterhouses, some of the OVs (5/25) received assistance in ante-mortem inspection from the OAs, and the distribution of tasks in ante-mortem inspection functioned well or very well according to 88% (22/25) of the red meat OVs and 95% (19/20) of the red meat slaughterhouse representatives. No significant differences were identified in the answers regarding the functionality between respondent groups or between OVs receiving assistance from OAs compared with those who did not ($p > 0.05$, Kruskal-Wallis test and Mann-Whitney U-test).

The task distribution in post-mortem inspection was functioning well or very well in the opinion of 88% (22/25) of the red meat OVs, 89% (8/9) of the poultry OVs, 83% (30/36) of the red meat OAs, and 90% (46/51) of the poultry OAs. Of the slaughterhouse representatives, 75% (15/20) in red meat slaughterhouses and 100% (8/8) in poultry slaughterhouses assessed the distribution of post-mortem inspection tasks to function well or very well. No significant differences were found between the respondent groups' answers ($p > 0.05$, Kruskal-Wallis test). The main reason why the red meat OAs were

not entirely satisfied with the task distribution was difficulties of Evira in recruiting substitutes for the OAs (2/36 mentioned this) (unpublished results). One red meat OA also mentioned that the OV should anticipate when extra hands are required in the inspection and assist OAs when carcasses of poorer quality are inspected (unpublished results). Red meat slaughterhouse representatives did not further clarify this issue (unpublished results).

The inspection of FCI, performed by the OVs and slaughterhouse operators, functioned well or very well according to only 32% (8/25) of red meat OVs, 78% (7/9) of poultry OVs, and 75% of both red meat (15/20) and poultry (6/8) slaughterhouse representatives. Respondents observed several problems in providing and checking the FCI (Figure 1). More than half of the red meat OVs, red meat slaughterhouse representatives, and officials in the control department noted that farmers do not provide FCI properly. For instance, providing information on sick animals was often neglected (two OVs and two officials in the control department mentioned this) (unpublished results). Individual OVs also noted that the questions in the declaration form were too general, farmers did not understand the purpose of the FCI, and no sanctions were incurred by farmers in case of incomplete or faulty information (unpublished results).

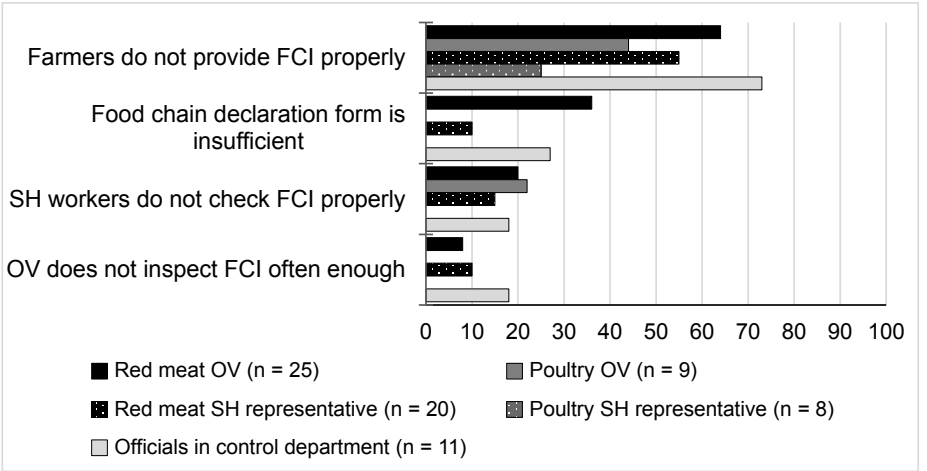

Figure 1. *Respondents in each group (%) who observed the following problems in the food chain information (FCI) inspection in slaughterhouses (SHs) in Finland in 2013. OV = official veterinarian.*

5.2.2 PERCEIVED IMPORTANCE OF MEAT INSPECTION TASKS (I)

Based on the means of the respondent groups' answers regarding the importance of FCI, ante-mortem inspection and post-mortem inspection in

relation to quality and safety of the meat, animal welfare, and prevention of transmissible animal diseases, respondents assessed the importance of ante-mortem inspection as highest (mean 6.5), post-mortem inspection as second highest (mean 6.3) and FCI inspection as lowest (mean 5.4) (scale from 1 = "very unimportant" to 7 = "very important"). All respondent groups assessed FCI and ante- and post-mortem inspections on average as at least somewhat important. Red meat OVs considered the importance of FCI inspection for animal welfare to be significantly smaller (mean 4.5) than the control department (mean 6.3) ($p = 0.043$, Kruskal-Wallis test). Post-mortem inspection was considered to be very important in relation to all factors by both the red meat and poultry OAs.

All of the respondent groups considered palpation and incision of intestines and related lymph nodes to be the least important of the post-mortem tasks in red meat slaughterhouses (unpublished results) (Figure 2). Although OVs assessed the visual inspection of intestines as important, the palpation and incision were seen as somewhat unimportant. Slaughterhouse operators evaluated all tasks, except for palpation and incision of intestines, as less important than the other groups (unpublished results) (Figure 2).

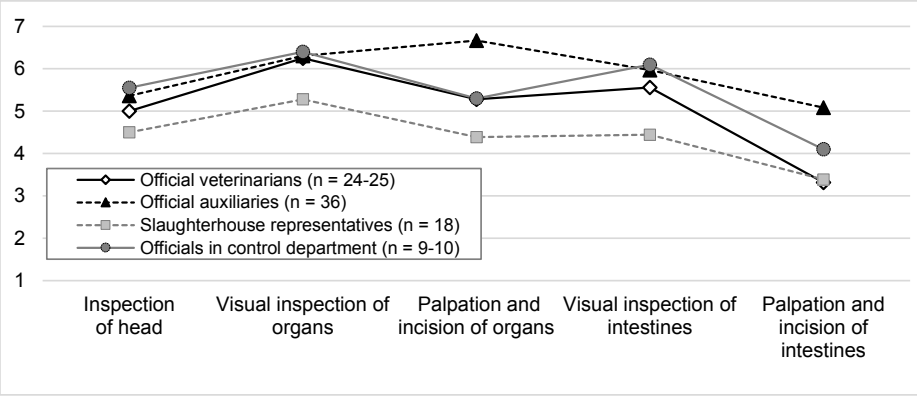

Figure 2. *Respondent groups' mean answers regarding the importance of post-mortem inspection tasks in red meat slaughterhouses. All of the inspection tasks also included the inspection of related lymph nodes. Scale: 1 = highly unimportant, 2 = unimportant, 3 = somewhat unimportant, 4 = neither important nor unimportant, 5 = somewhat important, 6 = important, 7 = highly important (unpublished results).*

5.2.3 CHANGING THE DISTRIBUTION OF MEAT INSPECTION TASKS (I)

The majority of respondents in each group did not support the change of red meat OAs' employer from the authority to the slaughterhouse (Figure 3). Especially for consumer confidence, the post-mortem inspection performed

by OAs employed by the authority was seen as important in red meat slaughterhouses (Figure 3). Red meat OAs, in particular, were concerned that if their employer would change to the slaughterhouse it would affect meat inspection decisions negatively and decrease their expertise (Figure 3).

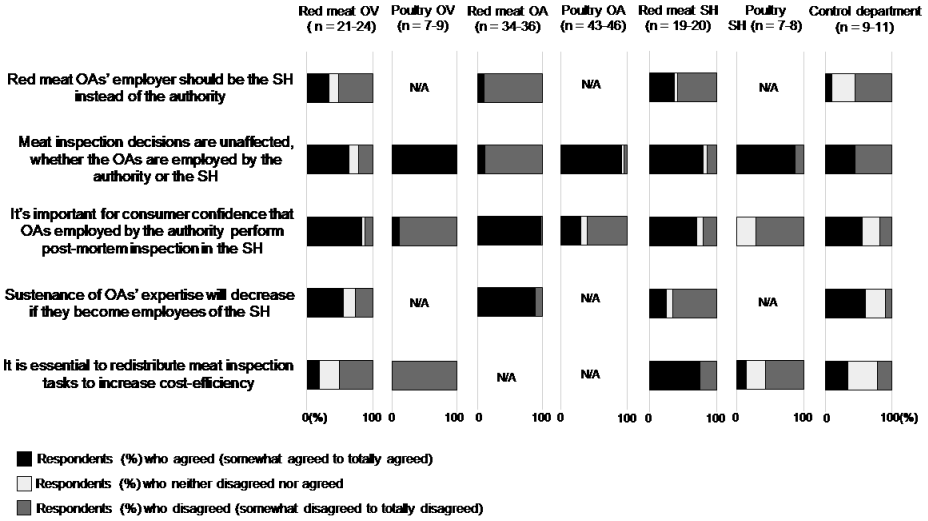

Figure 3. *Respondents' opinions on redistribution of meat inspection tasks in slaughterhouses (SHs) in Finland in 2013. OV = official veterinarian, OA = official auxiliary, red meat SH = red meat slaughterhouse representative, poultry SH = poultry slaughterhouse representative, control department = officials in the control department of Evira who guided and organized official control in SHs at the central level, N/A = not applicable/question not asked.*

The assigning of ante-mortem inspection from OVs to OAs was supported by none of the OVs, 13% (4/32) of the red meat OAs, 2% (1/42) of the poultry OAs, and 15% (3/20) of the red meat slaughterhouse representatives. The most common reason stated why the red meat OVs did not support redistribution of ante-mortem inspection to OAs was that they believed that the OAs lacked sufficient expertise and knowledge (4/25). The reasons why some of the red meat slaughterhouse representatives were willing to redistribute ante-mortem inspection to OAs were as follows: because they believed that the OAs could perform the task as skillfully as the OVs (3/3), perceived economic benefit (3/3), and lack of OV resources (2/3) (unpublished results). The majority of persons in each respondent group still considered it important that OVs perform ante-mortem inspection and whole-carcass condemnation (Table 5).

Table 5. *Respondents' views on the importance of official veterinarians (OVs) performing ante-mortem inspection and whole-carcass condemnation in 2013.*

Respondent group	Importance of OVs performing ante-mortem inspection			Importance of OVs performing whole-carcass condemnation		
	Somewhat important to very important	Neither important nor unimportant	Somewhat unimportant to very unimportant	Somewhat important to very important	Neither important nor unimportant	Somewhat unimportant to very unimportant
Red meat OV (n = 25)	100%	0%	0%	92%	4%	4%
Poultry OV (n = 9)	100%	0%	0%	N/A[a]	N/A	N/A
Red meat OA[b] (n = 36)	86%	6%	8%	92%	3%	6%
Poultry OA (n = 47)	96%	0%	4%	N/A	N/A	N/A
Red meat SH[c] representative (n = 20)	60%	0%	40%	100%	0%	0%
Poultry SH representative (n = 7)	100%	0%	0%	N/A	N/A	N/A

[a]Not applicable
[b]Official auxiliaries
[c]Slaughterhouse

5.2.4 SUFFICIENCY OF THE NUMBER OF MEAT INSPECTION PERSONNEL (II)

A frequent or constant shortage of OVs was experienced by 3/14 chief OVs, and the rest experienced shortage more seldom (5/14) or never (6/14). Food safety inspections (chosen by 7/8 chief OVs), participation of meat inspection personnel in further training (6/8), and guidance and support given to OAs (5/8) were seen as the main areas suffering from the shortage of OVs. However, none of the OVs stated that ante- and post-mortem inspections or surveillance of transmissible animal diseases would be affected from the shortage of OVs. Shortage of OAs was experienced by 8/14 chief OVs, two of whom in red meat slaughterhouses stated that the shortage had been frequent or constant. Difficulties in finding substitutes for the OVs and OAs were underlying inadequate meat inspection personnel resources in most cases. Organizing substitutes for the OAs was difficult according to 4/7 chief OVs in red meat slaughterhouses and according to none of the poultry chief OVs. At least in one poultry slaughterhouse, the OAs worked every other week in meat inspection and in production, and therefore, organizing substitutes for the OAs was perceived as easy by the OV and by 7/8 OAs (unpublished results).

5.2.5 MEAT INSPECTION SKILLS AND EVALUATION OF OFFICIAL AUXILIARIES' PERFORMANCE (II)

Nearly all of the chief OVs (13/14) considered the skills of the regular OAs in post-mortem inspection to be totally sufficient. However, five chief OVs, one of whom was from a poultry slaughterhouse, did not assess the skills of OA substitutes as totally sufficient in performing post-mortem inspection. Red meat OAs were significantly more often of the opinion that the skills of their substitutes were not totally sufficient (answered by 79%) compared with poultry OAs (answered by 29%) ($p < 0.05$, Fisher's exact test). The majority of red meat OVs (11/16) and OAs (11/18) assessed the maintenance of post-mortem inspection skills of OA substitutes as insufficient, whereas 2/5 OVs and 7/32 OAs in poultry slaughterhouses found the maintenance of skills to be insufficient.

In red meat slaughterhouses, much variation existed in the frequency with which OVs observed post-mortem inspection performed by OAs and in duration of observation each time (Figure 4). The performance of the OAs was not sufficiently evaluated according to 33% (6/18) of the red meat OAs and 9% (3/34) of the poultry OAs ($p < 0.05$, Fisher's exact test). OVs conducted performance tests for poultry OAs in three of the four poultry slaughterhouses, and in one they were about to be introduced.

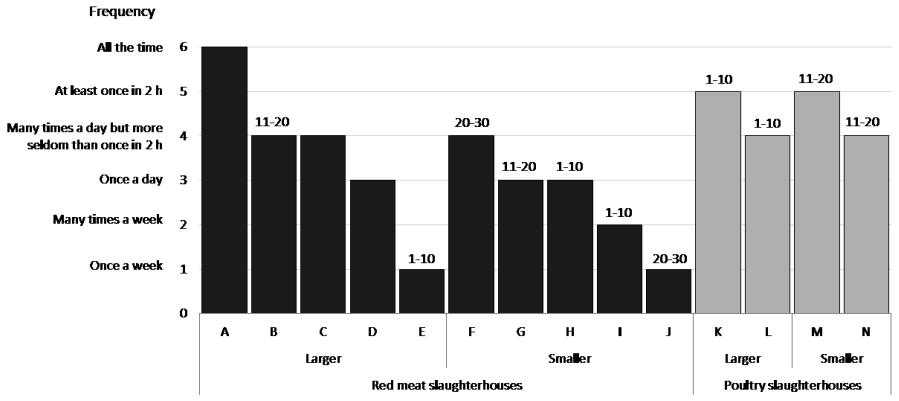

Figure 4. *Frequency with which official veterinarians (OVs) observed post-mortem inspections performed by official auxiliaries in slaughterhouses according to chief OVs in 14 slaughterhouses in Finland. The numbers above the bars describe the time used by OVs for observation each time in minutes (given if the OV mentioned the time). Larger slaughterhouses processed over 1000 red meat animals or over 200 000 birds per week and smaller slaughterhouses less than these limits.*

5.2.6 INDEPENDENCE FROM THE SLAUGHTERHOUSE IN MEAT INSPECTION (II)

The importance of independence of the OAs from the slaughterhouse in meat inspection was not entirely clear for all OAs. Of the poultry OAs, 88% totally (59%) or partly (29%) agreed that the OAs understand working independently from the slaughterhouse. In red meat slaughterhouses, 96% of the OAs totally (75%) or partly (21%) agreed with the same statement. The rest of the OAs partly or totally disagreed with this statement. One of the six OVs in poultry slaughterhouses noted that the OAs do not understand working independently from the slaughterhouse and that poultry OAs do not understand the OV's role as the leader in meat inspection. Of the red meat OAs, 11/23 answered that the slaughterhouse tries to affect meat inspection decisions at least occasionally. The corresponding results for poultry OAs, red meat OVs, and poultry OVs were 5/36, 2/19, and 0/5, respectively.

5.2.7 OFFICIAL VETERINARIANS' EXPERTISE IN FOOD SAFETY LEGISLATION AND ADMINISTRATIVE SKILLS (III)

The majority of the chief OVs partly or totally agreed that the expertise of the OVs in food safety legislation (13/13) and in administration (10/13) were sufficient in the slaughterhouse (Figure 5). The chief OVs in slaughterhouses with high severity of non-compliance were less satisfied with OVs' expertise in food safety legislation (p=NS, Mann-Whitney U-test) and their administrative skills ($p < 0.05$, Mann-Whitney U-test) than OVs in other slaughterhouses.

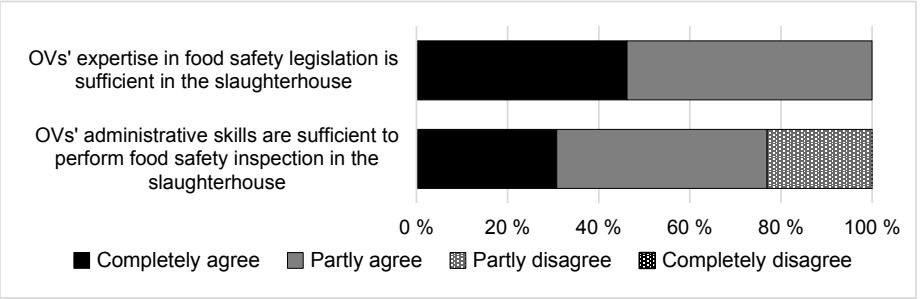

Figure 5. *Chief official veterinarians' (OVs') (n = 13) perceptions of the expertise of OVs in the slaughterhouse.*

5.2.8 FURTHER TRAINING OF MEAT INSPECTION PERSONNEL (II)

Participation in further training was considered important by 18/19 OVs and 22/24 OAs in red meat slaughterhouses, and by 5/5 OVs and 22/32 OAs in

poultry slaughterhouses. The most important topics for further training were the application of legislation (chosen by 60% of OVs) and animal diseases (chosen by 52% of OAs). About half (13/24) of the red meat and poultry OVs participated in further training regarding their work at least two times a year, whereas half (13/24) of the red meat OAs participated in further training organized at the central level at least once a year. Difficulties in getting substitutes were mentioned by 14/23 OAs and 3/25 OVs to hinder the participation in further training as often as preferred (unpublished results). Poultry OAs did not receive further training organized at the central level, but the majority of poultry OVs, OAs, and slaughterhouse representatives (4/5, 17/31, and 2/3, respectively) assessed it as necessary in the future. Most of the chief OVs (3/4), responsible for the further training of poultry OAs, could not organize training occasions often enough in their opinion.

5.2.9 GUIDANCE AND SUPPORT GIVEN TO MEAT INSPECTION PERSONNEL (II)

Of the red meat OAs, 29% did not agree that the guidance and support from the OVs in meat inspection was sufficient, whereas 11% of the poultry OAs did not agree with the statement ($p < 0.05$, Mann-Whitney U-test). Most of the red meat OVs (78%) totally agreed that the OVs are sufficiently available for OAs, but only 38% of the red meat OAs totally agreed with the statement ($p < 0.05$, Mann-Whitney U-test).

The majority of the chief OVs did not consider the guidance that they received from the central authority to be sufficiently rapid and also noted that the central authority is not aware of the practical problems related to meat and food safety inspections (Figure 6). The guidance regarding meat inspection was also assessed as insufficient by 46% (6/13) of the chief OVs (Figure 6).

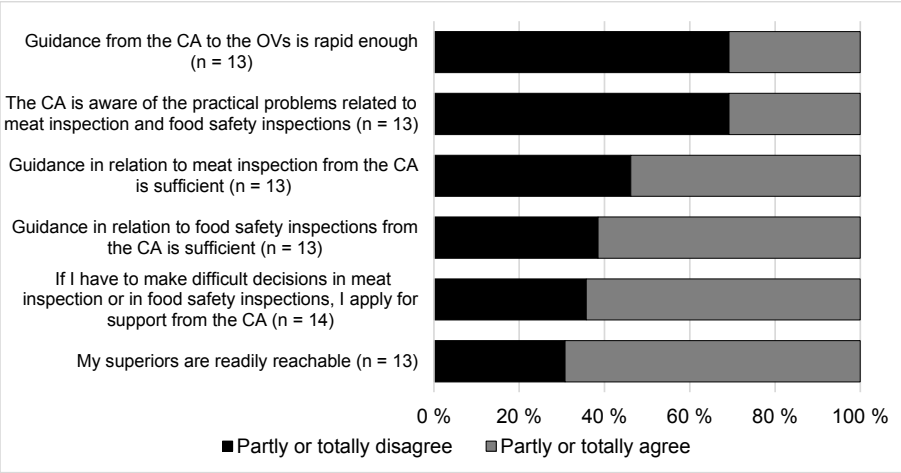

Figure 6. *Chief official veterinarians' (OVs') perceptions regarding the guidance and support received from the central authority (CA), i.e. the officials in the control department of Evira guiding and organizing official control in slaughterhouses.*

5.3 NON-COMPLIANCE OF SLAUGHTERHOUSE SELF-CHECKING SYSTEMS (III)

According to the chief OVs answers, the most common cases of non-compliance of the slaughterhouse SCSs were related to cleanliness of premises and equipment, hygienic working methods, and maintenance of surfaces and equipment (Figure 7). When these non-compliances were observed, they were in half or more of the cases observed occasionally or very seldom when inspected by the OVs, but mostly assessed as somewhat severe or severe in terms of meat safety (Figure 7). In smaller slaughterhouses compared with larger slaughterhouses, non-compliance was observed more frequently ($p < 0.05$, Mann-Whitney U-test) and non-compliance associated with sufficiency of premises was more common ($p < 0.05$, Mann-Whitney U-test).

The majority of the chief OVs (9/13) considered the self-checking plan of the slaughterhouse to meet the requirements of the food safety regulations well or very well. However, 39% of chief OVs stated that updating of the plan was insufficient. In slaughterhouses with high frequencies of non-compliance, the updating of the self-checking plan was assessed as less sufficient, and also the self-checking plan was considered to meet the requirements of the legislation poorer than in other slaughterhouses ($p < 0.05$, Mann-Whitney U-test). Chief OVs of two of the slaughterhouses with high frequencies of non-compliance considered that the slaughterhouse operator perceived the self-checking plan as somewhat or totally unimportant.

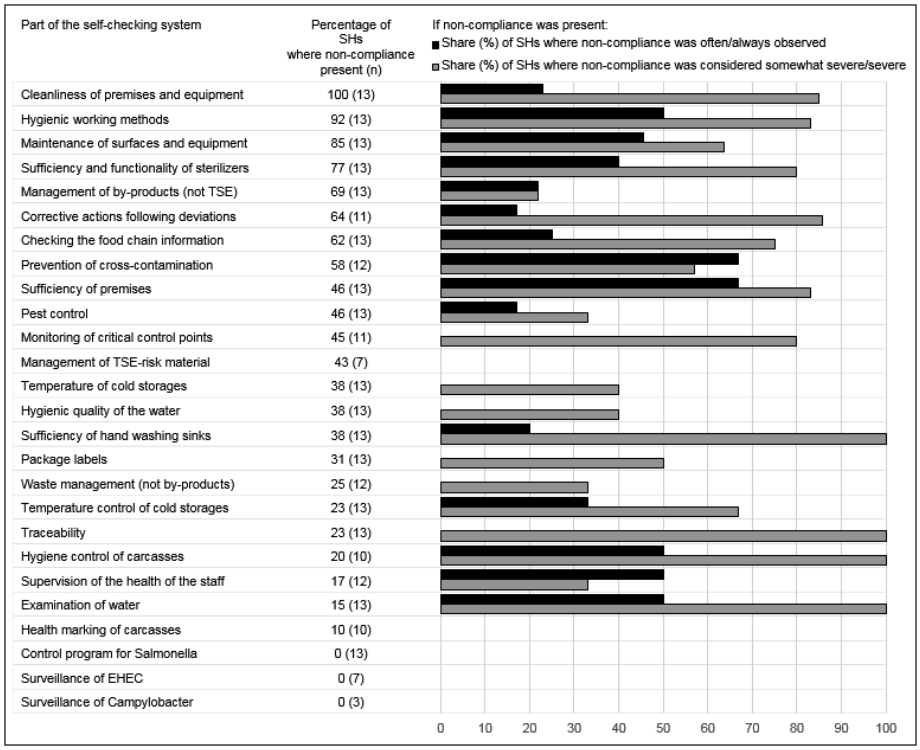

Figure 7. *Assessment by the chief OVs of the presence, frequency, and severity of non-compliance in various parts of the slaughterhouse self-checking systems during the previous year (May 2014). TSE = transmissible animal disease, EHEC = enterohemorrhagic Escherichia coli.*

5.4 CONTROL MEASURES USED BY THE OFFICIAL VETERINARIANS AND THEIR EFFICACY (III)

Based on the chief OVs' answers, the most common control measures used by the OVs in slaughterhouses were oral notification and documentation in their own records (Figure 8). In smaller slaughterhouses, oral notification without further action was more common than in larger slaughterhouses ($p < 0.05$, Mann-Whitney U-test). Written time limits for correction of non-compliance and enforcement measures had been used more frequently in other slaughterhouses than in slaughterhouses with high frequencies of non-compliance (presented in Section 5.1), where none of the OVs used written time limits often and enforcement measures had been used only in one of the slaughterhouses. In slaughterhouses with high frequencies of non-compliance, OVs also considered that more effective control measures should be used, whereas none of the OVs in other slaughterhouses agreed with this view ($p < 0.05$, Fisher's exact test).

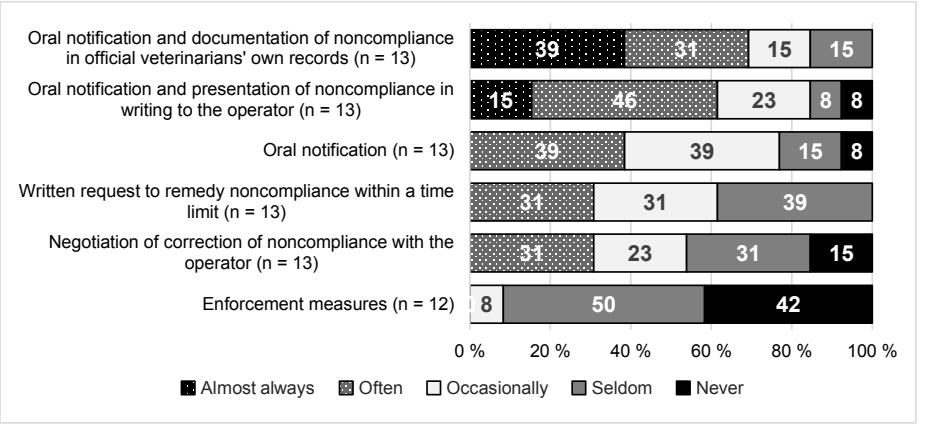

Figure 8. *Chief official veterinarians' answers on how often various control measures were applied in food safety inspections by official veterinarians in the slaughterhouse.*

5.5 DEFICIENCIES IN OFFICIAL CONTROL AND THEIR CORRECTION

5.5.1 DEFICIENCIES IN MEAT INSPECTION (IV)

Non-conformities in the documentation of meat inspection were observed in 3/18 slaughterhouses, and all of them were corrected based on OVs' reports. Nearly all of the bovine (10/11) and swine (5/7) slaughterhouses had non-conformities in the technical post-mortem inspection in at least one of the internal audits. The most common non-conformities concerned the palpation and possible incision of the gastric and mesenteric lymph nodes, and visual inspection of the udder and its lymph nodes. If non-conformities in the palpation of the gastric and mesenteric lymph nodes or inspection of the udder were observed, their correction demanded in most cases structural changes to the slaughter line or recruiting an extra OA. Most of the non-conformities in bovine and swine slaughterhouses were corrected or their correction had been initiated based on later audit reports or OVs' reports on the correction of non-conformities (52/60). The rest of the non-conformities were not corrected (2/8) or their correction remained unclear (6/8) because the OV had not reported the measures taken.

In poultry slaughterhouses, only the meat inspection performed by the OVs was audited. In one of the four slaughterhouses, the OV did not perform the daily inspection of a representative sample in all cases due to a problematic construction of the slaughter line, and also the detailed inspection of a random

sample of condemned carcasses was insufficient. Both of the non-conformities were corrected based on later audits.

5.5.2 DEFICIENCIES IN FOOD SAFETY INSPECTIONS (IV)

In the internal audits of food safety inspections, none of the poultry slaughterhouses and 7/13 red meat slaughterhouses had non-conformities. Documentation of the food safety inspections had the most non-conformities (observed in 5/17 slaughterhouses), including insufficient or totally absent documentation of inspected areas, observations, or time limits for corrections. In 4/17 slaughterhouses, non-conformities were observed in the control measures, such as lack of systematic ensuring of approval of operations and premises, too seldom or insufficient checks of the SCS, and weak enforcement in relation to correction of unhygienic structures. In two smaller red meat slaughterhouses, OVs did not detect the slaughterhouse's non-compliance at the food safety inspection that they performed during the audit.

In addition to non-conformities, targets for development were observed in the food safety inspections of most slaughterhouses (15/17). Especially the documentation of the food safety inspection had targets for development (in 12/17 slaughterhouses), but also the follow-up of the correction of non-compliances (in 9/16 slaughterhouses), as the auditors were left with the impression that the follow-up inspections were not performed systematically after time limits for correction had passed. Targets for development in enforcement (observed in 5/17 slaughterhouses) included, for instance, that the OVs should had been more prone to use enforcement measures after the slaughterhouse had not corrected a non-compliance within the given time limit.

The number of smaller red meat slaughterhouses with non-conformities or targets for development in the enforcement was significantly greater than the number of larger slaughterhouses with these deficiencies ($p < 0.05$, Fisher's exact test). On average, more areas of official control with deficiencies per slaughterhouse were observed in the food safety inspections of smaller red meat slaughterhouses relative to larger red meat slaughterhouses, but the difference was not significant ($p = 0.051$, Mann-Whitney U-test).

Most of the non-conformities in food safety inspections were corrected according to the audit reports or OVs' reports of corrective actions (14/16). The correction of two non-conformities was unclear, as OVs' reports were missing.

5.6 INTERNAL AUDITS

5.6.1 NECESSITY, BENEFITS, AND FREQUENCY OF INTERNAL AUDITS (IV)

On a scale from "1 = highly unnecessary" to "10 = highly necessary", the chief OVs (n=13) assessed the internal audits of meat and food safety inspection on average as necessary (7.9 and 8.2, respectively). The means of auditors' answers (n =3-5) on the necessity of the internal audits of meat and food safety inspections were 8.3 and 9.4, respectively. Chief OVs considered the benefits from the internal audits to meat inspection to be significantly smaller (mean of the answers 5.3) than the benefits to food safety inspections (mean 8.7) on a scale from "1 = no benefit" to "10 = great benefit" ($p < 0.05$, Wilcoxon's signed rank test).

Benefits of the internal audits that were brought up by the interviewees were grouped into two categories: a) improvements to the quality of official control and b) improvements to guidance, support, and training. The most frequently mentioned benefits of the audits were that they initiate improvements and corrections to official control (mentioned by 16/21) and improve the slaughterhouse's correction of a non-compliance (mentioned by 15/21). Especially auditors (7/8) but also some of the chief OVs (4/13) deemed the audits important in receiving an image of the present state of official control in slaughterhouses. Concerning the benefits to guidance, support, and training, audits were seen as an important possibility for the OVs and the officials in central authority to have a discussion according to six of the OVs and all of the auditors. A substantial number of interviewees also mentioned that internal audits were beneficial because OVs receive support and a second opinion during the audits (8/21) and because the need for instructions and training of OVs could be assessed (7/21).

Most of the OVs (8/13) noted that internal audits of both meat and food safety inspections should be performed at least every third year in each slaughterhouse, and the rest of the OVs suggested more frequently. The majority (7/8) of auditors considered that all slaughterhouses should be audited every second or third year.

5.6.2 NEEDS FOR IMPROVEMENT OF INTERNAL AUDITS (IV)

From the chief OVs' and auditors' answers to the open-ended questions, four themes for improvement of audits emerged: a) content of audits, b) expertise of auditor, c) audit process and practices, and d) follow-up of audits. Of the

interviewees, 8/21 considered that the audits, especially meat inspection audits (6/8), should be more thorough, and 5/13 chief OVs mentioned that the uniformity of meat inspection should also be audited. The auditors were hoped to have more experience with meat inspection and with working as OVs by six chief OVs and by two auditors in order to be able to audit more meaningfully. Including an OV or an OA on the audit team was mentioned by 2/13 chief OVs and by 1/8 auditors. Two OVs and auditors stated that the OVs needed more support and guidance during the audits. Especially if enforcement measures are deemed necessary during the audits, more support should be given according to the OVs. Most of the auditors (5/8) and one OV also mentioned that the follow-up of the correction of non-conformities should be developed, with OVs' reports being less ambiguous and all reports consistently filed.

6 DISCUSSION

6.1 IMPROVING PREREQUISITES FOR HIGH-QUALITY OFFICIAL CONTROL IN RED MEAT AND POULTRY SLAUGHTERHOUSES

6.1.1 MEAT INSPECTION TASKS AND THEIR DISTRIBUTION

Our results show that meat inspection personnel, slaughterhouse representatives, and officials in the control department of Evira were mainly satisfied with the task distribution in ante-mortem and post-mortem inspections, and changes to the task distribution between OAs, OVs, and slaughterhouse employees were not commonly supported. However, some (3/20) red meat slaughterhouse representatives were willing to assign ante-mortem to OAs for economic benefit, and also a small proportion of OAs (4/32) supported this suggestion. When contemplating possible reassignment of ante-mortem inspection from OVs to OAs, many aspects need to be taken into account. Ante-mortem inspection was perceived as the most important task in inspection for quality and safety of meat, animal welfare, and prevention of transmissible animal diseases, and the majority of each respondent group considered it important that the OVs perform ante-mortem inspection. EFSA has also evaluated ante-mortem inspection as essential for meat safety and for detecting animal welfare and health conditions (EFSA, 2011, 2012). In ante-mortem inspection, animals need to be checked for conditions that might adversely affect human and animal health, clinical inspection must be performed when needed, and further actions with possible far-reaching consequences must be taken when necessary (EU, 2004d). Signs of compromised animal welfare should also be detected, and observed deficiencies must be addressed (EU, 2004d). Therefore, the inspector must have sufficient competency, authority, expertise, and knowledge regarding a wide range of subjects (Anonymous, 2013b; Det Norske Veritas, 2011).

The majority of the respondents in each respondent group disagreed that the employer of the official red meat auxiliaries should be the slaughterhouse. Consistent with previous reports in the UK (Pope et al., 2013; TNS-BMRB, 2010), our respondents assessed post-mortem inspection performed by the authority as especially important for consumer confidence in red meat slaughterhouses. Red meat OAs, in particular, were concerned that if they were to be employed by the slaughterhouse, meat inspection decisions would be affected and their expertise over time would decrease. Examples from the past

show that reduced authority supervision in slaughterhouses can lead to lower meat safety (Dutch Safety Board, 2014; Nestor & Hauter, 2000), use of unqualified personnel in meat inspection, and pressure from the slaughterhouse for certain meat inspection decisions (Nestor & Hauter, 2000). The concerns of the respondents should thus be recognized. If red meat slaughterhouses were to employ the individual for post-mortem inspection in the future, adequate supervision by the OVs and maintenance of OAs' meat inspection skills should be ensured. Interestingly, respondent groups in poultry slaughterhouses did not find slaughterhouse-employed post-mortem inspectors to be problematic for consumer confidence. The fact that nearly all respondents in the red meat slaughterhouses deemed it highly important that whole-carcass condemnation is performed by the OV stresses the importance of the presence of authority surveillance in red meat slaughterhouses. Condemnation has an marked impact on meat safety, but it also causes considerable economic losses (Boyle et al., 2012), both of which likely influence respondents' views on task distribution.

OVs' and OAs' perceptions of the high importance of ante-mortem and post-mortem inspections presumably contribute to the quality of these inspections, as the perceived importance of a work task has been shown to have a positive effect on motivation, and thus, performance (Frank & Lewis, 2004; Hackman & Lawler, 1971; Robbins, 2000). The meaningfulness of work has also been demonstrated to be the most important factor having a positive effect on OVs' work motivation (Rahkio et al., 1995).

The importance of FCI inspection was assessed as somewhat lower than that of ante- and post-mortem inspections, which is most likely due to the problems with the FCI declaration, decreasing its usability in meat inspection. FCI is an essential tool in a more risk-based meat inspection (EFSA, 2011, 2012, 2013a; Lawless & Wiedemann, 2011), and it should provide reliable information on the animals' and herd's health (Anonymous, 2014; Huey, 2012). Therefore, especially in red meat slaughterhouses, deficiencies in the declaration form and the filling of the form by the farmer should be improved. Our results indicate that also Finnish farmers might lack sufficient understanding of the importance of FCI – a factor previously suspected to affect motivation in providing FCI (Alban et al., 2011; Anonymous, 2013a) – which decreases its accuracy and usability. In order to increase farmers' knowledge and motivation to provide accurate FCI, training should be organized, and sanctions should be considered for farmers submitting incorrect FCI (Anonymous, 2013b). In addition, deficiencies in the declaration form in red meat slaughterhouses ought to be corrected, and, as suggested by

Felin et al. (2016), well-chosen symptoms with proper guidelines for reporting, among other essential information, should be included.

6.1.2 MEAT INSPECTION PERSONNEL-RELATED PREREQUISITES

To maintain quality of official control, a sufficient number of qualified meat inspection personnel is a necessity. In our survey, a constant lack of OVs was experienced by the chief OVs in 3/14 slaughterhouses and a more infrequent lack in 5 slaughterhouses. Lack of personnel is of concern since it can be presumed to impact especially the quality of food safety inspections; this task was reported to suffer most from the shortage of OVs. However, our results are also reassuring for the quality of meat inspection performed by the OVs, as none of the OVs mentioned that the shortage of OVs affected ante-mortem inspection, post-mortem inspection, or surveillance of transmissible animal diseases. OVs undoubtedly prioritize the tasks in which they have the main responsibility, whereas slaughterhouses bear the main responsibility in assuring that operations and conditions in the slaughterhouse fulfil the legislative requirements through implementing their SCSs. Although OVs mainly verify proper implementation of SCSs via food safety inspections, the importance of this task cannot be overestimated. Slaughterhouses have been reported to have difficulties in implementing their SCSs (Alban et al., 2011; EC, 2013; FVO, 2013; Kotsanopoulos & Arvanitoyannis, 2017a), and poor hygiene in slaughterhouses has been associated with serious food poisoning outbreaks (Anonymous, 2006a; Lewis et al., 2013; Tuttle et al., 1999). Therefore, sufficient OV resources in all slaughterhouses should be guaranteed, enabling OVs to perform food safety inspections as thoroughly as required.

The skills of the regular OAs in post-mortem inspection were evaluated to be sufficient by all but one (13/14) chief OV. Still, our results show that the post-mortem inspection skills of the OA substitutes and the maintenance of their skills, especially in red meat slaughterhouses, were not considered to be adequate. If the post-mortem inspection is not skilfully and thoroughly performed, important signs and conditions affecting meat safety and quality, transmissible animal diseases, and welfare and health of the animals could go unnoticed (Alban et al., 2011; EFSA 2011). All personnel employed in meat inspection should work on a regular basis to maintain the uniform and quick inspection skills required in slaughter lines (Anonymous, 2013b).

In red meat slaughterhouses, the frequency with which OVs observed post-mortem inspection performed by the OAs varied markedly, and roughly one-

third of the red meat OAs did not find the evaluation of their performance and the guidance and support received from OVs in post-mortem inspection to be sufficient. Considering that the skills of OAs' substitutes were not always sufficiently maintained and that variation in the inspection decisions between OAs have been observed (Schleicher et al., 2013), the procedures to evaluate the performance of the red meat OAs in post-mortem inspection should be standardized. After the study period, Evira has prepared instructions on poultry OAs' performance tests that have most likely further unified the evaluation of OAs' performance. Our results suggest that common instructions for red meat OAs' evaluation would also be beneficial, although actual performance tests are not obligatory for the red meat OAs (EU, 2004d). Increased communication and interaction between the OVs and OAs are also recommended, as a strong working relationship, frequent and ongoing dialogue, and good co-operation have been assessed to improve the consistency and efficacy of official control in slaughterhouses (Pope et al., 2013).

Further training is also important for maintaining sufficient skills and knowledge to perform meat inspection, and our results showed that both the OAs and OVs had positive attitudes towards further training. However, difficulties in finding substitutes for the OAs seemed to hinder OAs' participation in further training. Poultry OAs did not receive further training organized at the central level, in contrast to the OAs in red meat slaughterhouses, although the majority of the respondents in poultry slaughterhouses considered that further training ought to be centrally organized. It is also of concern that the OVs bearing the responsibility of poultry OAs' further training did not find the time used for a training session to be adequate, and also the FVO assessed the training of Finnish poultry OAs to be insufficient (FVO, 2009b). These results advocate systematic and additional training also for poultry OAs.

OVs were keen to receive further training regarding the application of legislation, which suggests that the OVs do not find the interpretation of the legislation and making decisions based on it always easy. In addition, our results suggest that training on administrative procedures should be organized, as the chief OVs in slaughterhouses with a high severity of non-compliance were less satisfied with OVs' administrative skills than were the chief OVs in other slaughterhouses.

For the consistency and quality of meat inspection, it is important that the OAs make meat inspection decisions independently from the slaughterhouses (EU, 2004d). If the OAs are present at the slaughterhouse every day, the independency from the slaughterhouse can become somewhat obscure and is

not always easy to retain (Pope et al., 2013). In poultry slaughterhouses, the situation can be even more challenging because OAs' superiors are slaughterhouse employees, and the salary is paid by the slaughterhouse. Our results suggest that independence from the slaughterhouse, especially in poultry slaughterhouses, was not entirely clear to all OAs. Therefore, it is of the utmost importance that independence from the slaughterhouse in meat inspection is highlighted particularly for poultry OAs in the future. This matter also warrants a more thorough investigation.

6.1.3 DEMAND FOR INCREASED GUIDANCE FOR OFFICIAL VETERINARIANS

Various results in our study highlight the need to increase guidance and support for OVs. Most chief OVs stated that they turn to officials in the control department of Evira when they must make a challenging decision in official control and that their superiors are readily reachable. However, the guidance could be more rapid and the officials better aware of the practical problems related to official control of slaughterhouses according to the chief OVs. Also the sufficiency of guidance, especially in relation to meat inspection from the central authority, was criticized by many of the chief OVs. In official control, it would be beneficial to ensure that the officials responsible for guidance of OVs have sufficient experience as OVs or that they otherwise have an opportunity to gain enough knowledge and understanding regarding OVs' work. Skills of superiors in core actions are considered to contribute to improved performance of organizations (Goodall, 2012; Salas et al., 2010).

Results from the internal audit reports and interviews concerning the audits also support the need for increased guidance. In many slaughterhouses, non-conformities observed in internal audits in meat inspection were due to the lack of a sufficient number of OAs or defective slaughterhouse structures, the correction of which would have demanded considerable resources from the slaughterhouse. This indicates that when actions of a more difficult nature are required, OVs should receive adequate support from the superiors. Chief OVs also saw internal audits as an important venue for discussions with officials in the central authority. A few of them mentioned that when enforcement measures are deemed necessary based on audits, OVs require more support in executing the measures. Guidance has also been assessed as one of the most important ways to increase the uniformity of food safety inspections (Kettunen et al., 2018; Lee-Woolf et al., 2015; Läikkö-Roto et al., 2015). Based on the internal audits, the OVs in two slaughterhouses had not detected a non-compliance, and control approaches, e.g. usage of enforcement measures,

varied between smaller and larger slaughterhouses. These results indicate that the consistency of official control could be improved in Finnish slaughterhouses, and also from this point of view, the guidance should be improved.

6.2 NON-COMPLIANCE OF SLAUGHTERHOUSES AND IMPROVEMENT OF SELF-CHECKING SYSTEMS

In our study, the most common non-compliances of slaughterhouse SCSs concerned cleanliness, hygienic working methods, and maintenance of surfaces and equipment. These deficiencies have been observed in slaughterhouses world-wide (Cook et al., 2017; EC, 2013; FVO, 2002, 2010, 2013; Govender & Genis, 2010; Govender, 2012; Gramenzi et al., 2013; Lewis et al., 2013; Masanganise et al., 2013; Pacholewicz et al., 2016; Tuttle et al., 1999; Xiong et al., 2017). It is of concern that chief OVs had observed unhygienic working methods in all but one slaughterhouse during the year preceding the questionnaire and in half of the slaughterhouses often or always when inspected. Unhygienic slaughter procedures and working methods have been established to have a significant impact on contamination of meat (Baer et al., 2013; Baptista et al., 2010; Berends et al., 1997; EFSA, 2011; Guergueb et al., 2014; Habib, et al., 2012; Hudson et al., 1996; Lindblad & Berking, 2013; Osés et al., 2012; Rahkio & Korkeala, 1996), and slaughterhouse process hygiene has been assessed as even more relevant for ensuring biological meat safety than meat inspection (Blagojevic, & Antic, 2014; Blagojevic et al., 2012). Therefore, slaughterhouses should improve their SCSs regarding hygiene.

Our results support previous studies where smaller food businesses (Conter et al., 2007; Fielding et al., 2005; Kök, 2009; Losito et al., 2011; Walker et al., 2003), including slaughterhouses and meat plants (Govender, 2012; Kotsanopoulos & Arvanitoyannis, 2017a; Xiong et al., 2017), have been reported to have more difficulties in implementing their SCSs than larger food businesses. In smaller slaughterhouses, non-compliance was observed more frequently than in larger slaughterhouses, and all of the slaughterhouses where non-compliance was most frequent and severe were smaller slaughterhouses. The chief OVs in slaughterhouses with high frequencies of non-compliance also considered that their slaughterhouse staff perceived the self-checking plan as less important and found the updating and content of the plan as less sufficient than did the chief OVs in other slaughterhouses. Higher frequency of non-compliance in smaller slaughterhouses can be due to multiple factors that in previous studies have been shown to hinder effective

implementation of SCSs in smaller food businesses. Possible factors include lack of food safety knowledge (Fairman & Yapp, 2004; Yapp & Fariman, 2006), shortage of labour (Charlebois & Summan, 2014; Lewis & Peters, 2012; Local Food Research Center, 2012; Summan, 2013), and insufficient economic resources (Charlebois & Summan, 2014; Summan, 2013; Thompson, 2012). However, it is possible that the slaughterhouses with high frequencies of non-compliance also have poorer food safety culture. Recent studies have shown that FBOs' and their employees' commitment and attitude towards food safety have a marked effect on compliance (Ball et al., 2009, 2010; Fotopoulos et al., 2009; Läikkö-Roto & Nevas, 2014b; Mensah & Julien, 2011; Ramalho et al., 2015). Therefore, especially in smaller slaughterhouses, food safety culture ought to be evaluated in order to identify possible areas for improvement that could be addressed by, for instance, training slaughterhouse employees.

6.3 ENHANCING EFFICACY OF OFFICIAL CONTROL

For improving the efficacy of official control, control measures should be developed, especially in smaller slaughterhouses. According to the results of the questionnaire, OVs in smaller slaughterhouses used oral notification without further action more frequently than OVs in larger slaughterhouses, and, based on the internal audits, enforcement should be stronger in smaller slaughterhouses. Although an educative and collaborative approach of the food safety official towards especially smaller FBOs has been suggested to be favourable for compliance (Buckley, 2015; Fairman & Yapp, 2005; Newbold et al., 2008; Reske et al., 2007; Yapp & Fairman, 2006) and too strict enforcement to sometimes hinder compliance (Pope et al., 2013), our results suggest that in smaller slaughterhouses OVs should establish a stricter approach. In slaughterhouses where serious and frequent non-compliances were observed, lowering the threshold of initiating an enforcement process seems beneficial. FVO has also evaluated the enforcement in some of the Finnish slaughterhouses to be weak and highlighted the need to address, in particular, non-compliance related to hygiene more effectively (FVO 2009a).

In this study, availability of tools for enforcement measures, such as pre-forma templates and sufficient instructions, were not examined. However, it should be guaranteed that such tools are available for the OVs as they have been established to facilitate the use of enforcement measures (Kettunen et al., 2017b). Furthermore, written time limits for correction of slaughterhouses' non-compliance should be more systematically applied; they were less frequently used in slaughterhouses with high frequencies of non-compliance.

The importance of written time limits for the efficacy of controls has been shown also previously (Laikkö-Roto et al., 2015). To improve the uniformity and efficiency of control measures between slaughterhouses and to gain a new perspective on control activity, job rotation of the OVs could be useful as well.

In most of the slaughterhouses, deficiencies in the documentation of food safety inspections and in the follow-up of correction of non-compliances were observed during the internal audits. If the results of the inspections and required corrections are not adequately documented, and if the follow-up of the correction of a non-compliance is not systematically performed, it is likely that the control becomes inconsistent and inefficient. Implementation of the Oiva system has probably already improved some of the deficiencies in the official control, including deficiencies in documentation and enforcement, observed in this study. For instance, Oiva requires that all OVs prepare digital inspection reports, including information on non-compliances, corrective actions, and possible deadlines for the corrections (Evira, 2013). The system also aims to improve the uniformity of controls by providing thorough instructions and by obliging OVs to apply enforcement measures if the slaughterhouse is given the worst grade in the evaluation (Evira, 2013). In restaurants, disclosure systems have been effective in increasing the compliance (Anonymous, 2003; Bavorová et al., 2017) and improving the uniformity of food safety inspections (Thompson et al., 2005; Toronto Public Health, 2002). However, data on the effects of disclosure systems specifically in slaughterhouses have not yet been published. The effects of the Oiva system on the efficacy of food safety inspections and meat safety in slaughterhouses thus remain an interesting study subject of the future.

In meat inspection, non-conformities especially regarding the palpation and possible incision of gastric and mesenterial lymph nodes were common in post-mortem inspection of bovine and swine. These non-conformities have been observed in many other EU countries as well (Alban et al., 2011). Palpation and incision of intestines were assessed as the least important task in the post-mortem inspection by the OVs, which has probably led to other tasks being prioritized when lack of OAs exist. Although signs of inflammation can be detected in the intestines (Buncic, 2006; Jensen et al., 2008), the importance of the inspection of intestines has been questioned (Blagojevic et al., 2015), and for swine the inspection in the EU after the study period has been changed to primarily visual (EU, 2014b). Nevertheless, our results give incentive to criticize authorities' capacity to address non-conformities and enable meat inspection to be performed according to the legislation. When changes to the slaughterhouse structures or more OAs are needed, OVs should

initiate sufficient control measures or actions with the support and encouragement from their superiors to reach compliance.

6.4 IMPROVING AUDITING PROCEDURES

Internal audits were beneficial for official control; they had induced correction of non-conformities and they were perceived to improve the correction of slaughterhouse non-compliance. Although internal audits were assessed to be necessary for both meat and food safety inspections, measures to increase their benefits for meat inspection should be taken. The benefits received from internal audits should be made obvious also for auditees, as their perception of the usefulness of the audits is known to affect the impact of audits (Morin, 2001, 2004). Our results indicate that the benefits for meat inspection could be increased by more thorough audits, where also the rejections in meat inspection and their underlying reasons and uniformity are evaluated. Previous studies have shown that knowledge of auditors (Dittenhofer, 2001; Powell et al., 2013) and their credibility in the eyes of auditees (Morin, 2001, 2004) contribute to the impact of audits. Therefore, if more thorough auditing of meat inspection is performed in the future, the auditors must be experienced in meat inspection. Peer-auditing, by including an OV or OA from a different slaughterhouse on the audit team, could also be considered, as it was mentioned by some of the respondents.

Other need for improvement in auditing procedures concerned the follow-up of correction of non-conformities. For instance, the correction was not always clearly stated by the OVs and all reports were not available. Deficiencies in the reporting of outcome and the follow-up of non-conformities of the audits have been observed in other countries as well (EC, 2013; FVO, 2002). For proper utilization of inspection results, auditors must, without exception, receive information about whether non-conformities have been corrected, and the results must be filed in an easy-to-use format. Technology has an important role in making documents of food safety audits more accessible (Kotsanopoulos & Arvanitoyannis, 2017b) and could, in part, intensify the follow-up and utilization of audits.

Each EU member state should have adequate resources for audits (EC, 2006), but in some EU countries their frequency has been decreased because of scarce economic resources (EC, 2013). Our results attest to the importance of these audits, which should be performed at least every third year (or even more frequently) according to OVs and auditors.

According to the EC (EC, 2006), the auditors should be independent of the activity that they audit, but in Finland the auditors were involved in guiding and organizing official control in slaughterhouses. How auditors' involvement in audited controls may have affected audit results is difficult to determine, but one potential drawback would be an unwillingness of the auditors to spot deficiencies. This did not seem to be the case, however, as many non-conformities and targets for development were observed during audits. Furthermore, none of the respondents suggested that auditors' involvement in guiding and organizing official control should be changed in the future. On the contrary, auditors' involvement in the controls that were audited appeared to have some positive effects. For instance, a large number of OVs assessed the audits as beneficial for their guidance and support, and also auditors mentioned that the audits increased their expertise and knowledge of the present state of official control and its problems.

7 CONCLUSIONS

1. Perceptions of meat inspection personnel, slaughterhouse representatives, and central officials regarding the functionality of task distribution in meat inspection did not give any strong incentive to reorganize tasks in poultry or red meat slaughterhouses, although the need for cost reduction remains an important issue in redistribution of tasks. Several ways emerged to improve meat inspection personnel-related prerequisites for high-quality official control. These included ensuring a sufficient number of meat inspection personnel and a more systematic evaluation of OAs in red meat slaughterhouses to improve the uniformity of post-mortem inspection, offering further training centrally also for poultry OAs, and emphasizing the independence of OAs from the slaughterhouse in meat inspection. Furthermore the results strongly support giving greater emphasis to guidance of meat inspection personnel when developing slaughterhouse control. OVs should receive sufficient guidance and support from their superiors in decisions that require challenging interpretation of the legislation, use of enforcement measures, or expensive corrective actions from the slaughterhouse.

2. OVs reported non-compliances of slaughterhouse SCSs that were assessed to jeopardize meat safety, and some of these non-compliances occurred repeatedly. The most common non-compliances were observed in hygiene, e.g. cleanliness, hygienic working methods, and maintenance, and non-compliances were more common in smaller slaughterhouses than in larger slaughterhouses. Slaughterhouses, especially those with frequent and severe non-compliances, should take further actions to improve hygiene management in their SCSs.

3. In all slaughterhouses, OVs should invest in hygiene control, in improving documentation of food safety inspections, and in performing follow-up inspections systematically after time limits for corrections have passed. Particularly in smaller slaughterhouses with frequent and severe non-compliances, OVs should systematically give written time limits for corrections and consider lowering the threshold for initiating an enforcement process. Uniformity of control measures could be improved by job rotation of OVs in order to gain new perspectives on control activity.

OVs with adequate support from their superiors should also more actively address non-conformities in meat inspection.

4. The results clearly show the importance of internal audits in slaughterhouses, as the audits induced correction of non-conformities and were perceived to improve the correction of slaughterhouse non-compliances. The quality of meat inspection could be improved by including audits of rejections and their underlying reasons and uniformity by an experienced auditor. The follow-up of correction of non-conformities and the utilization of audit results should also be developed. In the future, the frequency of internal audits should be maintained or even increased.

REFERENCES

Abdul-Mutalib, N.-A., Abdul-Rashid, M.-F., Mustafa, S., Amin-Nordin, S., Hamat, R. A., & Osman, M. (2012). Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers in Kuala Pilah, Malaysia. *Food Control*, *27*(2), 289-293.

Alban, L., Steenberg, B., Stephensen, F. T., Olsen, A.-M., & Petersen, J. V. (2011). Overview on current practices of meat inspection in the EU. https://www.efsa.europa.eu/en/supporting/pub/en-190. Accessed 31.7.2018.

Anonymous. (1975). Hallituksen esitys Eduskunnalle laiksi lihantarkastuslain muuttamisesta vp. n:o: 43.

Anonymous. (1982). Hallituksen esitys Eduskunnalle laiksi lihantarkastuslain muuttamisesta vp. n:o 193.

Anonymous. (2003). Food premises inspection and disclosure system. Evaluation report. Toronto Public Health, Healthy Environments Services. http://www.toronto.ca/health/dinesafe/pdf/food_safety_evaluation.pdf. Accessed 31.7.2018.

Anonymous. (2006a). *E.coli*-saken: Evaluering av myndighetenes og næringens håndtering vinter/vår 2006. Rapport fra det regjeringsoppnevnte evalueringsutvalget for *E.coli*-saken. https://evalueringsportalen.no/evaluering/e.coli-saken-evaluering-av-myndighetenes-og-naringens-haendtering-vinter-vaar-2006/301838-e-coli-rapport-151206.pdf/@@inline. Accessed 31.7.2018.

Anonymous. (2006b). Outbreak of Verotoxin positive *Esherichia coli* O157 infection in South Wales autumn 2005. Report of the outbreak control team 6th June 2006. http://iiumedic.net/biostatistics/v4/wp-content/uploads/2012/10/20121022-Ecolireport1.pdf. Accessed 31.7.2018.

Anonymous. (2006c). Risk-based meat inspection in a Nordic context. TemaNord. https://www.nordic-ilibrary.org/agriculture-and-food/risk-based-meat-inspection-in-a-nordic-context_tn2006-585. Accessed 31.7.2018.

Anonymous. (2008a). Assessment of risk for humans associated with supply chain meat inspection – the Danish way. December 2008. http://www.forskningsdatabasen.dk/en/catalog/2192986902. Accessed 31.7.2018.

Anonymous. (2008b). Modernisation of veterinary inspection in abattoirs. Lyon Seminar (7 to 11 July, 2008) Contents. http://agriculture.gouv.fr/telecharger/44045?token=ec16cb6d9a7720a418eec77d4d37e0eb. Accessed 31.7.2018.

Anonymous. (2012). Summary of industry consultations on the B. C. abattoir inspection system review. Ministy of Health and Ministry of Agriculture, July 2012. http://www.bcsheep.com/docs/2012/2012-08-bcaisr_summary.pdf. Accessed 31.7.2018.

Anonymous. (2013a). An evaluation of food chain information (FCI) and collection and communication of inspection results (CCIR). MLCSL Final report – project FS145002. February 2013. https://www.food.gov.uk/sites/default/files/796-1-1409_Evaluation_of_Food_Chain_Information_FS145002.pdf. Accessed 31.7.2018.

Anonymous. (2013b). Animals + humans = one health. How to make meat official controls work for all?, 15th October 2013, Brussels. Report ref. 3559. http://www.worldvet.org/events.php?item=42&view=item. Accessed 31.7.2018.

Anonymous. (2013c). Final report of an audit conducted in the United States February 5th, through February 22nd, 2013 evaluating the food safety systems governing the production of meat and poultry products intended for export to Canada. http://www.inspection.gc.ca/food/meat-and-poultry-products/imports/audits-of-meat-inspection-programs/final-report-of-an-audit-us-/eng/1404919271012/1404921262798. Accessed 31.7.2018.

Anonymous. (2014). Meat and poultry inspection 2.0: How the United States can learn from the practices and innovations in other countries. A report from the PEW Charitable Trusts and the Center for Science in the Public Interest. http://www.pewtrusts.org/~/media/assets/2014/10/meat_and_poultry_inspection_artfinal_v5.pdf. Accessed 31.7.2018.

Ansari-Lari, M., Soodbakhsh, S., & Lakzadeh, L. (2010). Knowledge, attitudes and practices of workers on food hygienic practices in meat processing plants in Fars, Iran. *Food Control*, *21*(3), 260-263.

Baek, S.-H., Kang, S.-C., Lee, W.-C., & Nam, I.-S. (2012). Effects of HACCP system implementation on domestic livestock product plants. *Korean Journal for Food Science of Animal Resources*, *32*(2), 168-173.

Baer, A. A., Miller, M. J., & Dilger, A. C. (2013). Pathogens of interest to the pork industry: A review of research on interventions to assure food safety. *Comprehensive Reviews in Food Science and Food Safety, 12*(2), 183-217.

Ball, B., Wilcock, A., & Aung, M. (2009). Factors influencing workers to follow food safety management systems in meat plants in Ontario, Canada. *International Journal of Environmental Health Research*, *19*(3), 201-218.

Ball, B., Wilcock, A., & Aung, M. (2010). Background factors affecting the implementation of food safety management systems. *Food Protection Trends*, *30*(2), 78-86.

Baptista, F. M., Dahl, J., & Nielsen, L. R. (2010). Factors influencing *Salmonella* carcass prevalence in Danish pig abattoirs. *Preventive Veterinary Medicine*, *95*(3-4), 231-238.

Batz, M. B., Hoffmann, S., & Morris, JR. J. G. (2012). Ranking the disease burden of 14 pathogens in food sources in the United States using attribution data from outbreak investigations and expert elicitation. *Journal of Food Protection*, *75*(7), 1278-1291.

Bavorová, M., Fietz, A. V., & Hirschauer, N. (2017). Does disclosure of food inspections affect business compliance? The case of Berlin, Germany. *British Food Journal, 119*(1), 143-163.

Bavorová, M., & Hirschauer, N. (2012). Producing compliant business behaviour: disclosure of food inspection results in Denmark and Germany. *Journal für Verbraucherschutz und Lebensmittelsicherheit*, 7(1), 45–53.

Bawole, J. N., & Ibrahim, M. (2016). Contesting claims on measuring performance in the public sector using performance audits: evidence from the literature. *Public Organization Review, 16*(3)*,* 285-299.

Bell, R. G. (1997). Distribution and sources of microbial contamination on beef carcasses. *Journal of Applied Microbiology*, *82*(3), 292-300.

Berends B. R., Van Knapen, F., Snijders, J. M., & Mossel D. A. (1997). Identification and quantification of risk factors regarding *Salmonella* spp.

on pork carcasses. *International Journal of Food Microbiology, 36*(2-3), 199-206.

Blagojevic, B., & Antic, D. (2014). Assessment of potential contribution of official meat inspection and abattoir process hygiene to biological safety assurance of final beef and pork carcasses. *Food Control*, *36*(1), 174-182.

Blagojevic, B., Antic, D., & Buncic, S. (2012). A qualitative risk ranking of, and main control strategies for, biological hazards in relation to safety of chilled beef carcasses. Proceeding of International Conference "Biological Food Safety and Quality", 4–5 October 2012, Belgrade, Serbia, 121-124. http://agris.fao.org/agris-search/search.do?recordID=RS201300736. Accessed 31.7.2018.

Blagojevic, B., Dadios, N., Reinmann, K., Guitian, J., & Stärk, K. D. C. (2015). Green offal inspection of cattle, small ruminants and pigs in the United Kingdom: Impact assessment of changes in the inspection protocol on likelihood of detection of selected hazards. *Research in Veterinary Science*, *100*, 31-38.

Bolton, D. J., Pearce, R. A., Sheridan, J. J., Blair, I. S., McDowell, D. A., & Harrington, D. (2002). Washing and chilling as critical control points in pork slaughter hazard analysis and critical control point (HACCP) systems. *Journal of Applied Microbiology*, *92*(5), 893-902.

Bonde, M., Toft, N., Thomsen, P. T., & Sørensen, J. T. (2010). Evaluation of sensitivity and specificity of routine meat inspection of Danish slaughter pigs using Latent Class Analysis. *Preventive Veterinary Medicine*, *94*(3-4), 165-169.

Bonnaud, L., & Coppalle, J. (2013). Co-regulation in practices: the hygiene package in French slaughterhouses. *Sociologia Ruralis*, *53*(4), 479-495.

Borch, E., Kant-Muermans, M.-L., & Blixt, Y. (1996). Bacterial spoilage of meat and cured meat products. *International Journal of Food Microbiology, 33*(1), 103-120.

Boyle, L., Harley, S., O'Connell, N., Moore, S., O'Hanlon, A., & Teixeira, D. (2012). Improving pig welfare reduces carcass and financial losses. Teagasc—The Agriculture and Food Development Authority: Pig Farmers' Conference. 2012. http://www.thepigsite.com/articles/contents/12-11-10Teagasc_Pig_Conference_Proceedings_2012.pdf. Accessed 31.7.2018.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

BRC Global Standards. (2015). Food safety: a global view 2015. https://www.brcglobalstandards.com/media/9393/food-safety-a-global-view-2015.pdf. Accessed 31.7.2018.

Buckley, J. A. (2015). Food safety regulation and small processing: A case study of interactions between processors and inspectors. *Food Policy*, *51*, 74-82.

Buckley, J. A. (2016). Interpersonal skills in the practice of food safety inspections: a study of compliance assistance. *Journal of Environmental Health*, *79*(5), 8-12.

Buncic, S. (2006). Meat inspection of main animal species. In S. Buncic (ed.), *Integrated food safety and veterinary public health (pp. 184-188). CABI, Oxfordshire, UK.*

Buncic, S., Nychas, G.-J., Lee, M. R. F., Koutsoumanis, K., Hébraud, M., Desvaux, M., Chorianopoulos, N., Bolton, D., Blagojevic, B., & Antic D. (2014). Microbial pathogen control in the beef chain: Recent research advances. *Meat Science*, *97*(3), 288-297.

Carneiro, P., & Kaneene, J. B. (2017). Food inspection services: A comparison of programs in the US and Brazil. *Food Control*, *80*, 314-318.

Centers for Disease Control and Prevention. (2017). Surveillance for foodborne disease outbreaks, United States, 2015, Annual Report. Atlanta, Georgia: US Department of Health and Human Services, CDC. https://www.cdc.gov/foodsafety/pdfs/2015FoodBorneOutbreaks_508.pdf. Accessed 31.7.2018.

Charlebois, S., & Summan, A. (2014). Abattoirs, meat processing and managerial challenges: A survey for lagging rural regions and food entrepreneurs in Ontario, Canada. *International Journal of Rural Management*, *10*(1), 1-20.

Choi, J., & Scharff, R. L. (2017). Effect of a publicly accessible disclosure system on food safety inspection scores in retail and food service establishments. *Journal of Food Protection, 80*(7), 1188-1192.

Clayton, D. A., Griffith, C. J., Price, P., & Peters, A. C. (2002). Food handlers' beliefs and self-reported practices. *International Journal of Environmental Health Research*, *12*(1), 25-39.

Codex Alimentarius Commission. (2005). Code of hygienic practice for meat. CAC/RCP 58-2005. http://www.fao.org/input/download/standards/10196/CXP_058e.pdf. Accessed 5.4.2018.

Conter, M., Zanardi, E., Ghidini, S., Pennisi, L., Vergara, A., Campanini, G., & Ianieri, A. (2007). Survey on typology, PRPs and HACCP plan in dry fermented sausage sector of Northern Italy. *Food Control*, *18*(6), 650-655.

Cook, E. A. J., Anson de Glanville, W., Thomas, L. F., Kariuki, S., de Clare Bronsvoort, B. M., & Fèvre, E. M. (2017). Working conditions and public health risks in slaughterhouses in western Kenya. *BMC Public Health*, *17*(14), 1-12.

Correia-Gomes, C., Smith, R. P., Eze, J. I., Henry, M. K., Gunn, G. J., Williamson, S., & Tongue, S. C. (2016). Pig abattoir inspection data: Can it be used for surveillance purposes? *PLOS One*, *11*(8), 1-10.

Daujotaitė, D., & Mačerinskienė, I. (2008). Development of performance audit in public sector. 5th International scientific conference: business and management, 16-17 May 2008, Vilnius, Lithuania (pp. 177-185).

Davies, M. H., Webster, S. D., Hadley, P. J., & Stosic, P. J. (2000). Production factors that influence the hygienic condition of finished beef cattle. *Veterinary Record*, *146*, 179-183.

De Boeck, E., Jacxsens, L., Bollaerts, M., Uyttendaele, M., & Vlerick, P. (2016). Interplay between food safety climate, food safety management system and microbiological hygiene in farm butcheries and affiliated butcher shops. *Food Control*, *65*, 78-91.

De Boeck, E., Jacxsens, L., Bollaerts, M., & Vlerick, P. (2015). Food safety climate in food processing organizations: Development and validation of a self-assessment tool. *Trends in Food Science & Technology*, *46*(2), 242-251.

Desmarchelier, P., Fegan, N., Smale, N., & Small, A. (2007). Managing safety and quality through the red meat chain. *Meat Science*, *77*(1), 28-35.

Det Norske Veritas. (2011). MC1005: Ante-mortem inspection of prime red meat and poultry by official auxiliaries rather than official veterinarians: Final report. BA000568-4. Accessed 31.7.2018.

Dittenhofer, M. (2001). Performance auditing in governments. *Managerial Auditing Journal*, *16*(8), 438-442.

Duggan, S. J., Mannion, C., Prendergast, D. M., Leonard, N., Fanning, S., Gonzales-Barron, U., Egan, J., Butler, F., & Duffy G. (2010). Tracking the *Salmonella* status of pigs and pork from lairage through the slaughter process in the Republic of Ireland. *Journal of Food Protection*, *73*(12), 2148-2160.

Dutch Safety Board. (2014). Summary - Risks in the meat supply chain. The Hague, March 2014. https://www.onderzoeksraad.nl/en/onderzoek/1910/risks-in-the-meat-supply-chain. Accessed 31.7.2018.

Dwinger, R. H., Golden, T. E., Hatakka, M., & Daelman, W. (2007). The "hygiene package" – a new approach to food safety. ISAH-2007. https://www.isah-soc.org/userfiles/downloads/proceedings/Proc_ISAH_2007_Volume_I/04_Dwinger.pdf. Accessed 31.7.2018.

Edwards, D. S., Johnston, A. M., & Mead, G. C. (1997). Meat inspection: an overview of present practices and future trends. *The Veterinary Journal*, *154*(2), 135-147.

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing, 62*(1), 107-115.

Emameh, R. Z., Purmonen, S., Sukura, A., & Parkkila, S. (2018). Surveillance and diagnosis of zoonotic foodborne parasites. *Food Science and Nutrition, 6*(1), 3-17.

Eriksson, E., Aspan, A., Gunnarson, A. & Vågsholm, I. (2005). Prevalence of verotixin-producing *Escherichia coli* (VTEC) O157 in Swedish dairy herds. *Epidemiology and Infection*, *133*(2), 349-358.

European Centre for Disease Prevention and Control. (2018a). Communicable disease threats report. CDTR, week 10, 4-10 March 2018. https://ecdc.europa.eu/sites/portal/files/documents/Communicable-disease-threats-report-10-mar-2018.pdf. Accessed 31.7.2018.

European Centre for Disease Prevention and Control. (2018b). Communicable disease threats report. CDTR, week 13, 25-31 March 2018. https://ecdc.europa.eu/sites/portal/files/documents/Communicable-disease-threats-report-31-mar-2018.pdf. Accessed 31.7.2018.

European Commission. (2000). White Paper on food safety. http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l32041&from=FI. Accessed 31.7.2018.

European Commission. (2006). European Commission Decision of 29 Sebtember 2006 setting out the guidelines laying down criteria for the conduct of audits under Regulation (EC) No 882/2004 of the European Parliament and of the Council on official controls to verify compliance with feed and food law, animal health and animal welfare rules (EC No 677/2006). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:278:0015:0023:EN:PDF, Accessed 31.7.2018.

European Commission. (2013). Report from the Commission to the European Parliament and to the Council on the overall operation of official controls in the Member States on food safety, animal health and animal welfare, and plant health. (COM(2013) 681 final). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0681:FIN:EN:PDF. Accessed 31.7.2018.

European Commission. (2016). The EU Food Fraud Network and the System for Administrative Assistance & Food Fraud: Annual Report 2016.

https://ec.europa.eu/food/sites/food/files/safety/docs/food-fraud_network_activity_report_2016.pdf. Accessed 31.7.2018.

European Communities. (2005). The European code of good administrative behaviour. Luxembourg: Office for Official Publications of the European Communities. https://www.ombudsman.europa.eu/en/resources/code.faces#/page/1. Accessed 31.7.2018.

European Food Safety Authority. (2011). Scientific Opinion on the public health hazards to be covered by inspection of meat (swine). *EFSA Journal*, *9*(10), 2351. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2011.2351/epdf. Accessed 31.7.2018.

European Food Safety Authority. (2012). Scientific Opinion on the public health hazards to be covered by inspection of meat (poultry). *EFSA Journal*, *10*(6), 2741. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2012.2741/epdf. Accessed 31.7.2018.

European Food Safety Authority. (2013a). Scientific Opinion on the public health hazards to be covered by inspection of meat (bovine animals). *EFSA Journal*, *11*(6), 3266. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2013.3266/epdf. Accessed 31.7.2018.

European Food Safety Authority. (2013b). Scientific Opinion on the public health hazards to be covered by inspection of meat from sheep and goats. *EFSA Journal, 11*(6), 3265. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2013.3265/epdf. Accessed 31.7.2018.

European Food Safety Authority & European Centre for Disease Prevention and Control. (2016). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015. EFSA Journal, 14(12), 4634. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2016.4634/epdf. Accessed 31.7.2018.

European Free Trade Association Surveillance Authority. (2012). Final report EFTA Surveillance Authority mission to Iceland from 7 to 16 May 2012 regarding the application of EEA legislation related to the safety of food of animal origin, in particular meat, milk and their products. http://www.eftasurv.int/media/reports/644199_Final-report-from-a-mission-to-Iceland-from-7-to-16-May-2012-regarding-application.pdf. Accessed 31.7.2018.

European Free Trade Association Surveillance Authority. (2014). Final report of EFTA Surveillance Authority mission to Iceland from 4 to 8 November 2013 regarding the application of EEA legislation related to the food safety control systems in place governing the production and placing on the market of poultry meat and products thereof. http://www.eftasurv.int/media/reports/700541.pdf. Accessed 31.7.2018.

European Union. (2002a). Council Directive 2002/99/EC of 16 December 2002 laying down the animal health rules governing the production, processing, distribution and introduction of products of animal origin for human consumption. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0099&qid=1523613467593&from=EN. Accessed 31.7.2018.

European Union. (2002b). Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general

principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:031:0001:0024:en:PDF. Accessed 31.7.2018.

European Union. (2004a). Directive 2004/41/EC of the European Parliament and of the Council of 21 April 2004 repealing certain Directives concerning food hygiene and health conditions for the production and placing on the market of certain products of animal origin intended for human consumption and amending Council Directives 89/662/EEC and 92/118/EEC and Council Decision 95/408/EC. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004L0041&qid=1515998435564&from=EN. Accessed 31.7.2018.

European Union. (2004b). Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0001:0054:en:PDF. Accessed 31.7.2018.

European Union. (2004c). Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004R0853&rid=1. Accessed 31.7.2018.

European Union. (2004d). Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:226:0083:0127:EN:PDF. Accessed 31.7.2018.

European Union. (2004e). Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:165:0001:0141:EN:PDF. Accessed 31.7.2018.

European Union. (2005a). Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005R2073&from=EN. Accessed 31.7.2018.

European Union. (2014a). Commission Regulation (EU) No 218/2014 of 7 March 2014 amending Annexes to Regulations (EC) No 853/2004 and (EC) No 854/2004 of the European Parliament and of the Council and Commission Regulation (EC) No 2074/2005. https://www.fsai.ie/uploadedFiles/Reg218_2014.pdf. Accessed 31.7.2018.

European Union. (2014b). Commission Regulation (EU) No 219/2014 of 7 March 2014 amending Annex I to Regulation (EC) No 854/2004 of the European Parliament and of the Council as regards the specific requirements for post-mortem inspection of domestic swine. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0219&from=FI. Accessed 31.7.2018.

European Union. (2017). Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products, amending Regulations (EC) No 999/2001, (EC) No 396/2005, (EC) No 1069/2009, (EC) No 1107/2009, (EU) No 1151/2012, (EU) No 652/2014, (EU) 2016/429 and (EU) 2016/2031 of the European Parliament and of the Council, Council Regulations (EC) No 1/2005 and (EC) No 1099/2009 and Council Directives 98/58/EC, 1999/74/EC, 2007/43/EC, 2008/119/EC and 2008/120/EC, and repealing Regulations (EC) No 854/2004 and (EC) No 882/2004 of the European Parliament and of the Council, Council Directives 89/608/EEC, 89/662/EEC, 90/425/EEC, 91/496/EEC, 96/23/EC, 96/93/EC and 97/78/EC and Council Decision 92/438/EEC (Official Controls Regulation). http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R0625&from=EN. Accessed 31.7.2018.

Evira. (2008). Laitoksen valvontaohje (Eviran ohje 16003/1).

Evira. (2011). Elintarvikeketjun monivuotinen kansallinen valvontasuunnitelma 2011-2015. https://www.evira.fi/globalassets/tietoa-evirasta/julkaisut/oppaat/elintarvikeketjun_monivuotinen_vasu_2011_2015.pdf. Accessed 31.7.2018.

Evira. (2012). Elintarviketurvallisuusviraston lihantarkastusyksikön työjärjestys. Helsinki 20.12.2012.

Evira. (2013). Oiva brings consumers to the door of your company. https://www.evira.fi/globalassets/tietoa-evirasta/julkaisut/esitteet/elintarvikkeet/oiva_esite_uk.pdf. Accessed 31.7.2018.

Evira. (2014a). Elintarvikeketjun monivuotinen kansallinen valvontasuunnitelma 2015 - 2019. Evira/4162/0410/2014. Retrieved from https://www.evira.fi/globalassets/tietoa-evirasta/julkaisut/oppaat/elintarvikeketjun_monivuotinen_vasu_2015-2019_fi.pdf. Accessed 31.7.2018.

Evira. (2014b). Raportti Suomen elintarvikeketjun monivuotisen kansallisen valvontasuunnitelman 2012 - 2016 toteutumisesta vuonna 2013. Evira/843/0411/2014. https://www.evira.fi/globalassets/tietoa-evirasta/esittely/toiminta/valvonta/arviointi--ja-raportit/vasu_raportti_2013.pdf. Accessed 31.7.2018.

Evira. (2015a). Elintarvikehuoneiston omavalvonnan riskiperusteinen valvonta. Eviran ohje 16043/1. https://www.evira.fi/globalassets/tietoa-evirasta/lomakkeet-ja-ohjeet/elintarvikkeet/elintarvikehuoneistot/eviran_ohje_16043.pdf. Accessed 31.7.2018.

Evira. (2015b). Siipikarjateurastamossa työskentelevien lihantarkastusavustajien pätevyysvaatimukset ja suoritusarvioinnit. Eviran ohje 16039/1. https://www.evira.fi/globalassets/tietoa-evirasta/lomakkeet-ja-ohjeet/elintarvikkeet/laitokset/siipikarja/eviran_ohje_16039_1.pdf. Accessed 31.7.2018.

Evira. (2016a). Elintarviketietojen Oiva-julkistamisjärjestelmä. Eviran ohje 10504/1. https://www.evira.fi/globalassets/tietoa-evirasta/lomakkeet-ja-ohjeet/elintarvikkeet/elintarvikehuoneistot/elintarvikevalvontatietojen-oiva-julkaisujarjestelma.pdf. Accessed 31.7.2018.

Evira. (2016b). Elintarviketurvallisuus Suomessa 2015. 4/2016. https://www.evira.fi/globalassets/tietoa-evirasta/esittely/toiminta/valvonta/2015/eviran_julkaisuja_4_2016.pdf. Accessed 31.7.2018.

Evira. (2016c). Elintarviketurvallisuusviraston määräys elintarvikevalvontaviranomaisen ilmoitus- ja tiedonantovelvollisuuden toteuttamistavasta ja valvontatietojen julkistamisesta. http://www.finlex.fi/fi/viranomaiset/normi/408001/42493. Accessed 31.7.2018.

Evira. (2016d). Lihantarkastuksen järjestäminen. Evira's webpage. https://www.evira.fi/elintarvikkeet/valmistus-ja-myynti/valvonta/lihantarkastus/lihantarkastuksen-jarjestaminen/. Accessed 31.7.2018.

Evira. (2017a). Elintarvikehuoneiston riskiluokitus ja valvontatarpeen määrittäminen. Eviran ohje 10503/2: https://www.evira.fi/globalassets/tietoa-evirasta/julkaisut/oppaat/eviran_ohje_10503_2_fi.pdf. Accessed 31.7.2018.

Evira. (2017b). Elintarvikeketjun monivuotinen kansallinen valvontasuunnitelma 2015 – 2019 (Osa I). Päivitys vuodelle 2018. Strategiset päämäärät ja toimenpiteet niiden saavuttamiseksi, johtamisjärjestelmä sekä resurssit. Evira/5797/0410/2017.://www.evira.fi/globalassets/vasu-2018-2019.pdf. Accessed 31.7.2018.

Evira. (2017c). Elintarviketurvallisuus Suomessa 2016. Eviran julkaisuja 3/2017. https://www.evira.fi/globalassets/tietoa-evirasta/julkaisut/julkaisusarjat/elintarvikkeet/eviran_julkaisuja_3_2017.pdf. Accessed 31.7.2018.

Evira. (2017d). Oiva evaluation guidelines for approved food establishments. https://www.oivahymy.fi/wp-content/uploads/2017/07/oiva-arviointiohjeet-hyvaksytyille-elintarvikehuoneistoille-03072017-eng.pdf. Accessed 31.7.2018.

Fairman, R., & Yapp, C. (2004). Compliance with food safety legislation in small and micro-businesses: enforcement as an external motivator. *Journal of Environmental Health Research*, *3*(2). http://www.cieh.org/jehr/jehr3.aspx?id=11454&LangType=2057&newwindow=true. Accessed 31.7.2018.

Fairman, R., & Yapp, C. (2005). Enforced self-regulation, prescription, and conceptions of compliance within small businesses: The impact of enforcement. *Law & Policy*, 27(4), 491–519.

Felin, E., Jukola, E., Raulo, S., Heinonen, J., & Fredriksson-Ahomaa, M. (2016). Current food chain information provides insufficient information for modern meat inspection of pigs. *Preventive Veterinary Medicine, 127,* 113-120.

Fielding, L. M., Ellis, L., Beveridge, C., & Peters, A. C. (2005). An evaluation of HACCP implementation status in UK small and medium enterprises in food manufacturing. *International Journal of Environmental Health Research*, *15*(2), 117-126.

Fillion, K., & Powell, D. A. (2009). The use of restaurant inspection disclosure systems as a means of commincating food safety information. *Journal of foodservice, 20*(6), 287–297.

Fillion, K., & Powell, D. (2011). Designing a national restaurant inspection disclosure system for New Zealand. *Journal of Food Protection, 74*(11), 1869-1874.

Fong, K., Falardeau, J., Rideout, K., Wilcott, L., Fong, D., & Wang, S. (2017). Opinions of provincial food safety specialists on addressing Canadian beef processing risks. *Food Protection Trends, 37*(5), 316-331.

Food and Agriculture Organization of the United Nations & World Health Organization. (2003). Assuring food safety and quality: Guidelines for strengthening national food control systems. FAO Food and Nutrition Paper, 76. http://www.fao.org/3/a-y8705e.pdf. Accessed 31.7.2018.

Food and Drug Administration. (2011). The FDA food safety modernization act. US Food and Drug Administration. https://www.gpo.gov/fdsys/pkg/PLAW-111publ353/pdf/PLAW-111publ353.pdf. Accessed 31.7.2018.

Food and Veterinary Office. (2002). Overview of the results of a series of missions carried out during 2000-2001 to evaluate controls over pig meat production in Member States. DG(SANCO)/9005/2002. http://ec.europa.eu/food/audits-analysis/overview_reports/act_getPDF.cfm?PDF_ID=95. Accessed 31.7.2018.

Food and Veterinary Office. (2009a). Final report of a specific audit carried out in Finland from 08 to 18 september 2009 in order to evaluate the follow-up action taken by the competent authorities with regard to official controls related to the safety of food of animal origin, in particular meat, milk and their products in the context of a general audit. DG(SANCO) 2009-8229 - MR FINAL. http://ec.europa.eu/food/audits-analysis/audit_reports/details.cfm?rep_id=2369. Accessed 31.7.2018.

Food and Veterinary Office. (2009b). Final report of a specific audit carried out in Finland from 02 June to 11 June 2009 in order to evaluate the food safety control systems in place governing the production and placing on the market of poultry meat and poultry meat products in the context of a general audit. DG(SANCO)/2009-8065-MR-FINAL. http://ec.europa.eu/food/fvo/act_getPDF.cfm?PDF_ID=7763. Accessed 31.7.2018.

Food and Veterinary Office. (2010). General report of a mission series carried out in six Member States in the period November 2009 to March 2010 in order to gather infofrmation regarding the application of the hygiene regulations in small establishments producing meat and meat products of mammals and dairy products. DG(SANCO)/2010-6150-MR FINAL. http://ec.europa.eu/food/fvo/specialreports/2010_6150_en.pdf. Accessed 31.7.2018.

Food and Veterinary Office. (2013). Overview report of a series of audits carried out in 2011 and 2012 in order to evaluate the official controls related to slaughter and processing of fresh meat, in particular fresh equine meat. DG(SANCO) 2013-6950. http://ec.europa.eu/food/fvo/specialreports/act_getPDF.cfm?PDF_ID=124. Accessed 31.7.2018.

Food and Veterinary Office. (2015). United Kingdom: Coutry Profile. Organization of official controls. Ref. Ares(2015)5523463 - 02/12/2015. http://ec.europa.eu/food/audits-analysis/country_profiles/details.cfm?co_id=GB#ControlSystems. Accessed 31.7.2018.

Food Safety and Inspection Service. (1996). Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems; Final Rule. Federal

Register, 61, 144. https://www.fsis.usda.gov/wps/wcm/connect/e113b15a-837c-46af-8303-73f7c11fb666/93-016F.pdf?MOD=AJPERES. Accessed 31.7.2018.

Food Safety and Inspection Service. (2017). Final report of an audit conducted in Canada September 12-30, 2016 evaluating the food safety system governing the production of meat, poultry, and egg products exported to the United States of America. https://www.fsis.usda.gov/wps/wcm/connect/47a53113-929a-430d-b4f0-22123d97b133/Canada-2016-FAR.pdf?MOD=AJPERES. Accessed 31.7.2018.

Food Safety Authority of Ireland. (2012). Audit report: Audit of official controls carried out at local authority approved slaughterhouses - Galway County Council. November 2012. https://www.google.fi/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjWnvirlpvYAhXSKFAKHZAbCB8QFggxMAA&url=https%3A%2F%2Fwww.fsai.ie%2Fauditofofficialcontrolsatlocalauthorityapprovedslaughterhousesgalwaycountycouncil.html&usg=AOvVaw3gItEfZix5JQODOL178QVn. Accessed 31.7.2018.

Food Standards Agency. (2007). Review of the delivery of official controls in approved meat premises: final report. FSA 07/07/06. http://www.reading.ac.uk/foodlaw/pdf/uk-07025-meat-controls-report.pdf. Accessed 31.7.2018.

Food Standards Agency. (2011). Outcomes and values of current ante and post-mortem inspection tasks & assessment of the benefits to public and animal health of post-mortem inspection of green offal in red meat species at slaughter. MC1003/FS245010. https://www.food.gov.uk/sites/default/files/703-1-1194_MC1003_final-report.pdf. Accessed 31.7.2018.

Food Standards Agency. (2013). Final report - Review on the current guidance available for small food manufacturers in the UK on the implementation of HACCP principles as required by the Food Hygiene Regulations. REP/FMT/126226/4. https://www.food.gov.uk/sites/default/files/820-1-1500_FS101001_Campden_report_final_3.pdf. Accessed 31.7.2018.

Food Standards Agency. (2016). Red meat safety & clean livestock. https://www.food.gov.uk/sites/default/files/multimedia/pdfs/publication/redmeatsafety.pdf. Accessed 31.7.2018.

Food Standards Agency. (2018). Investigation report following media allegations relating to 2 Sisters Food Group (September 2017). https://www.food.gov.uk/sites/default/files/investigationreport.pdf. Accessed 30.4.208.

Fotopoulos, C. V., Kafetzopoulos, D. P., & Psomas, E. L. (2009). Assessing the critical factors and their impact on the effective implementation of a food safety management system. *International Journal of Quality & Reliability Management*, *26*(9), 894-910.

Frank, S. A., & Lewis, G. B. (2004). Government employees: working hard or hardly working? *The American Review of Public Administration*, *34*(1), 36-51.

Fylan, F. (2005). Semi-structured interviewing. In J. Miles & P. Gilbert (Ed.), A handbook of research methods for clinical and health psychology (pp. 65-78). New York, United States: Oxford University Press.

Gill, A., & Gill, C. O. (2010). Non-O157 verotoxigenic *Escherichia coli* and beef: A Canadian perspective. *The Canadian Journal of Veterinary Research. 74*(3), 161-169.

Gomes-Neves, E., Cardoso, C. S., Araújo, A. C., & da Costa, J. M. C. (2011). Meat handlers training in Portugal: A survey on knowledge and practice. *Food Control*, *22*(3–4), 501-507.

Goodall, A. H. (2012). A theory of expert leadership. IZA Discussion Paper No. 6566. http://ftp.iza.org/dp6566.pdf. Accessed 31.7.2018.

Gormley, F. J., Little, C. L., Rawal, N., Gillespie, I. A., Lebaigue, S., & Adak, G. K. (2011). A 17-year review of foodborne outbreaks: describing the continuing decline in England and Wales (1992-2008). *Epidemiology and Infection*. *139*(5), 688-699.

Govender, R. (2012). Advancing the hygiene management system at poultry abattoirs in Gauteng, South Africa. *Journal of New Generation Sciences*, *10*(3), 69-86. http://ir.cut.ac.za/handle/11462/618. Accessed 31.7.2018.

Govender, R., & Genis, E. M. (2010). Advancing the hygiene management system at red meat abattoirs in Gauteng. *Journal for New Generation Sciences*, 8(1), 64-79. http://ir.cut.ac.za/handle/11462/550. Accessed 31.7.2018.

Gramenzi, M., Guerrieri, O., Pancrazio, E. D., Pennisi, L., & Vergara, A. (2013). Improvement of production standards in a company leader in the poultry meat market: the competent authority's role. *Italian Journal of Food Safety*, *2*(2), 101-103.

Griffith, C. J, Livesey K. M., & Clayton, D. A. (2010a). Food safety culture: the evolution of an emerging risk factor? *British Food Journal*, *112*(4), 426-438.

Griffith, C. J., Livesey K. M., & Clayton, D. (2010b). The assessment of food safety culture. *British Food Journal*, *112*(4), 439-456.

Grossklaus, D. (1987). The future role of the veterinarian in the control of zoonoses. *Veterinary Quarterly*, *9*(4), 321-331.

Guergueb, N., Alloui, N., Ayachi, A., & Bennoune, O. (2014). Effect of slaughterhouse hygienic practices on the bacterial contamination of chicken meat. *Scientific Journal of Veterinary Advances*, *3*(5), 71-76.

Habib, I., Berkvens, D., De Zutter, L., Dierick, K., Van Huffel, X., Speybroeck, N., Geeraerd, A. H., & Uyttendaele, M. (2012). *Campylobacter* contamination in broiler carcasses and correlation with slaughterhouses operational hygiene inspection. *Food Microbiology*, *29*(1), 105-112.

Hackman, J. R., & Lawler, E. E. (1971). Employee reactions to job characteristics. *Journal of Applied Psychology*, *55*(3), 259-286.

Hadley, P. J., Holder, J. S., & Hinton, M. H. (1997). Effects of fleece soiling and skinning method on the microbiology of sheep carcasses. *The Veterinary Record*, *140*(22), 570-574.

Haltiala, T. (2013). Pienteurastamoiden valvonta ja valvontatulosten raportointi. Eläinlääkäripäivien luentokokoelma.

Hansson, I., Engvall, E. O., Vågsholm, I., & Nyman, A. (2010). Risk factors associated with the presence of *Campylobacter*-positive broiler flocks in Sweden. *Preventive Veterinary Medicine*, *96*(1-2), 114-121.

Harley, S., More, S., Boyle, L., O'Connell, N., & Hanlon, A. (2012). Good animal welfare makes economic sense: potential of pig abattoir meat inspection as a welfare surveillance tool. *Irish Veterinary Journal*, *65*(11).

Hatakka, M. (2011). Pienteurastamoiden ja riistan käsittelylaitosten lihantarkastuksen siirtäminen valtion tehtäväksi. Selvityshenkilö maija hatakan raportti ja suositukset. http://mmm.fi/documents/1410837/1801180/Pienteurastamoiden_lihan

tarkastus_valtiolle_121110.pdf/5ec83dea-1b62-4faa-ad76-48fc76d7532b. Accessed 31.7.2018.

Hathaway, S. C., & McKenzie, A. I. (1991). Postmortem meat inspection programs; separating science and tradition. *Journal of Food Protection, 54*(6), 471-475.

Hennekinne, J.-A., De Buyser, M.-L., & Dragacci, S. (2011). *Staphylococcus aureus* and its food poisoning toxins: characterization and outbreak investigation. *FEMS Microbiology Reviews*, *36*(4), 815-836.

Hielm, S., Tuominen, P., Aarnisalo, K., Raaska, L., & Maijala, R. (2006). Attitudes towards own-checking and HACCP plans among Finnish food industry employees. *Food Control, 17*(5), 402-407.

Hill, A., Brouwer, A., Donaldson, N., Lambton, S., Buncic, S., & Griffiths, I. (2013). A risk and benefit assessment for visual-only meat inspection of indoor and outdoor pigs in the United Kingdom. *Food Control, 30*(1), 255-264.

Hill, A. A., Horigan, V., Clarke, K. A., Dewé, T. C. M., Stärk, K. D. C., O'Brien, S., & Buncic, S. (2014). A qualitative risk assessment for visual-only *post-mortem* meat inspection of cattle, sheep, goats and farmed/wild deer. *Food Control, 38*, 96-103.

Ho, D. E. (2012). Fudging the nudge: Information disclosure and restaurant grading. *The Yale Law Journal, 122*(3), 574-677.

Ho, D. E. (2017). Does peer review work? an experiment of experimentalism. *Stanford Law Review*, *69*, 1-80.

Hong, C.-H., Todd, E. C. D., & Bahk, G.-J. (2008). Aerobic plate counts as a measure of hazard analysis critical control point effectiveness in a pork processing plant. *Journal of Food Protection, 71*(6), 1248-1252.

Hudson, W. R., Mead, G. C., & Hinton, M. H. (1996). Relevance of abattoir hygiene assessment to microbial contamination of British beef carcases. *Veterinary Record*, *139*(24), 587-589.

Huey, R. (2012). Thoroughly modern meat inspection. *Veterinary Record*, *170*(3), 68- 70.

Huneau-Salaün, A., Stärk, K. D. C., Mateus, A., Lupo, C., Lindberg, A., & Le Bouquin-Leneveu, S. (2015). Contribution of meat inspection to the surveillance of poultry health and welfare in the European Union. *Epidemiology and Infection*, *143*(11), 2459-2472.

Hussein, H. S., & Bollinger, L. M. (2005). Prevalence of Shiga toxin – producing *Escherichia coli* in beef cattle. *Journal of Food Protection, 68*(10), 2224-2241.

Hutter, B. M., & Amodu, T. (2009). Risk regulation and compliance: Food safety in the UK. London School of Economics and Political Science. http://www.lse.ac.uk/accounting/Assets/CARR/documents/S-R/Food-Safety-in-the-UK.pdf. Accessed 31.7.2018.

International Organization of Supreme Audit Institutions. (2003). Performance audit guidelines: ISSAI 3000, 3100. INTOSAI Publications. http://www.intosai.org/issai-executive-summaries/4-auditing-guidelines /general-auditing-guidelines.html. Accessed 31.7.2018.

Jayasinghe-Mudalige, U., & Henson, S. (2007). Identifying economic incentives for Canadian red meat and poultry processing enterprises to adopt enhanced food safety controls. *Food Control*, *18*(11), 1363-1371.

Jensen, H. E., Leifsson, P. S., Nielsen, O. L., Agerholm, J. S., & Iburg, T. (2008). Köttkontrol – patologanatomiska grunder. Biofolia, Frederiksberg, Danmark.

Johnsen, Å., Meklin, P., Oulasvirta, L., & Vakkuri, J. (2001). Performance auditing in local government: an exploratory study of perceived efficiency of municipal value for money auditing in Finland and Norway. *European Accounting Review*, *10*(3), 583-599.

Jokela, S., Vehmas, K., & Lundén, J. (2009). Food control officials' views on coercive measures in ensuring food safety. *Archiv für Lebensmittelhygiene*, *60*(4), 130-134.

Jones, T. F., Pavlin, B. I., LaFleur, B. J., Ingram, L. A., & Schaffner, W. (2004). Restaurant inspection scores and foodborne disease. *Emerging Infectious Diseases, 10*(4), 688-692.

Junttila, J. (2014). Auditing Official Controls. In T. Ninios, J. Lundén, H. Korkeala, & M. Fredriksson-Ahomaa (eds.), Meat inspection and control in the slaughterhouse (pp. 605-620). Chichester, UK: John Wiley & Sons, Ltd.

Kettunen, K., Nevas, M., & Lundén, J. (2015). Effectiveness of enforcement measures in local food control in Finland. *Food Control*, *56*, 41-46.

Kettunen, K., Lundén, J., Läikkö-Roto, T., & Nevas, M. (2017a). Towards more consistent and effective food control: learning from the views of food business operators. *International Journal of Environmental Health Research*, *27*(3), 215-229.

Kettunen, K., Nevas, M., & Lundén, J. (2017b). Challenges in using administrative enforcement measures in local food control. *Food Control, 76*, 34-41.

Kettunen, K., Pesonen, S., Lundén, J., & Nevas, M. (2018). Consistency and risk-basis of using administrative enforcement measures in local food control. *Food Control*, *85*, 199-211.

Khatri, Y., & Collins, R. (2007). Impact and status of HACCP in the Australian meat industry. *British Food Journal*, *109*(5), 343-354.

Kotisalo, N., Luukkanen, J., Fredriksson-Ahomaa, M., & Lundén, J. (2015). Effects of centralizing meat inspection and food safety inspections in Finnish small-scale slaughterhouses. *Food Policy*, 55, 15-21.

Kotisalo, N., & Nevas, M. (2009). Structural compliance in fish and meat processing establishments under municipal control in Finland. *Archiv für Lebensmittelhygiene*, *60*(6), 179-184.

Kotsanopoulos, K. V., & Arvanitoyannis, I. S. (2017a). Audit results of UK meat companies - critical analysis. *British Food Journal*, *119*(12), 2684-2697.

Kotsanopoulos, K. V., & Arvanitoyannis, I. S. (2017b). The role of auditing, food safety, and food quality standards in the food industry: a review. *Comprehensive Reviews in Food Science and Food Safety, 16*(5), 760-775.

Kök, M. S. (2009). Application of food safety management systems (ISO 22000/HACCP) in the Turkish poultry industry: A comparison based on enterprise size. *Journal of Food Protection, 72*(10), 2221-2225.

Laukkanen-Ninios, R., Fredriksson-Ahomaa, M., & Korkeala, H. (2014). Enteropathogenic *Yersinia* in the pork production chain: Challenges for control. *Comprehensive Reviews in Food Science and Food Safety*, *13*(6), 1165-1191.

Lawless, J., & Wiedemann, K. (2011). European meat inspection - continuity and change in building a (more) risk-based system of regulation. *European Food and Feed Law Review*, *6*(2), 96-103.

Leeuw, F. L. (2011). On the effects, lack of effects and perverse effects of performance audit. In J. Losdale, P. Wilkins, & T. Ling (Eds.), Performance auditing: Contribution to accountability in democratic government (pp. 231-247). Cheltenham: Edward Elgar.

Lee-Woolf, C., Bain, J., & Fell, D. (2015). Consistency in the delivery of official food safety controls: the role of organisational level factors. A report for the Food Standards Agency. https://www.food.gov.uk/sites/default/files/consistency-regulatory-work-research4.pdf. Accessed 31.7.2018.

Lepistö, O. (2008). The principle of good governance in environmental health compulsory actions. Helsinki, Finland, Department of Food and Environmental Hygiene, University of Helsinki. Doctoral dissertation. https://helda.helsinki.fi/handle/10138/18979. Accessed 31.7.2018.

Lepistö, O., & Hänninen, M.-L. (2011). Effects of legal aspects on the use of compulsory procedures in environmental health and food control. *Journal of Environmental Health Research*, *11*(2), 127-134.

Leslie, N. W. (2003). Training of auxiliaries (meat hygiene inspectors/meat technicians): A survey of training in the 15 EU Member States. https://www.google.fi/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjIlsjE7JrYAhXFJ50KHcCyAwAQFggxMAA&url=http%3A%2F%2Fwww.meatinspectors.co.uk%2FVET-AUXILIARIES.doc&usg=AOvVaw2GI1kskZjO8dSRyhcbY1vS. Accessed 31.7.2018.

Lewis, R. J., Corriveau, A., & Usborne, W. R. (2013). Independent review of XL Foods Inc. Beef Recall 2012. http://www.foodsafety.gc.ca/english/xl_reprt-rapprte.asp. Accessed 31.7.2018.

Lewis, C. B., & Peters, C. J. (2012). A capacity assessment of New England's large animal slaughter facilities as relative to meat production for the regional food system. *Renewable Agriculture and Food Systems*, *27*(3), 192-199.

Lindblad, M., & Berking, C. (2013). A meat control system achieving significant reduction of visible faecal and ingesta contamination of cattle, lamb and swine carcasses at Swedish slaughterhouses. *Food Control*, *30*(1), 101-105.

Local Food Research Center. (2012). Regional large-animal meat processing plants: Summary of economic viability. Appalachian Sustainable Agriculture Project, Asheville, North Carolina. http://asapconnections.org/downloads/asap-summary-of-economic-viability-regional-large-animal-meat-processing.pdf. Accessed 31.7.2018.

Losito, P., Visciano, P., Genualdo, M., & Cardone, G. (2011). Food supplier qualification by an Italian large-scale distributor: Auditing system and non-conformances. *Food Control*, *22*(12), 2047-2051.

Luning, P. A., Kirezieva, K., Hagelaar, G., Rovira, J., Uyttendaele, M., & Jacxsens, L. (2015).Performance assessment of food safety management systems in animal-based food companies in view of their context characteristics: A European study. *Food Control, 49*, 11-22.

Lynch, J. A., & Silva, P. (2013). Integrating animal health and food safety surveillance data from slaughterhouse control. *Scientific and Technical Review of the Office International des Epizooties*, *32*(2), 409-416.

Läikkö-Roto, T., & Nevas, M. (2014a). Auditing local official food control: Perceptions of auditors and auditees. *Food Control*, *37*, 135-140.

Läikkö-Roto, T., & Nevas, M. (2014b). Restaurant business operators' knowledge of food hygiene and their attitudes toward official food control affect the hygiene in their restaurants. *Food Control, 43*, 65-73.

Läikkö-Roto, T., Mäkelä, S., Lundén, J., Heikkilä, J., & Nevas, M. (2015). Consistency in inspection processes of food control officials and efficacy of official controls in restaurants in Finland. Food Control, 57, 341-350.

Maldonado-Siman, E., Bai, L., Ramírez-Valverde, R., Gong, S., Rodríguez-de Lara, R. (2014a). Comparison of implementing HACCP systems of exporter Mexican and Chinese meat enterprises. *Food Control*, *38*, 109-115.

Maldonado-Siman, E., Bernal-Alcántara R., Cadena-Meneses J. A., Altamirano-Cárdenas, J. R., & Martinez-Hernández, P. A. (2014b). Implementation of quality systems by Mexican exporters of processed meat. *Journal of Food Protection*, *77*(12), 2148-2152.

Masanganise, K. E., Matope, G., & Pfukenyi, D. M. (2013). A survey on auditing, aquality assurance systems and legal frameworks in five selected slaughterhouses in Bulawayo, sout-western Zimbabwe. *Onderstepoort Journal of Veterinary Research*, *80*(1), 1-8.

Mascini, P., & Wijk, E. V. (2009). Responsive regulation at the Dutch Food and Consumer Product Safety Authority: An empirical assessment of assumption underlying the theory. *Regulation & Governance*, *3*(1), 27–47.

Mazzette, R., Piras, F., Agus, V., Porcheddu, G., Fois, G., & Consolati, S. G. (2015). Hygiene and welfare evaluation of pigs slaughtered in agritourism. *Italian Journal of Food Safety*, *4*(2), 78-81.

Mead, P. S., Dunne, E. F., Graves, L., Wiedmann, M., Patrick, M., Hunter, S., Salehi, E., Mostashari, F., Craig, A., Mshar, P., Bannerman, T., Sauders, B. D., Hayes, P., Dewitt, W., Sparling, P., Griffin, P., Morse, D., Slutsker, L., & Swaminathan, B. (2006). Nationwide outbreak of listeriosis due to contaminated meat. *Epidemiology and Infection, 134*, 744-751.

Mensah, L. D., & Julien, D. (2011). Implementation of food safety management systems in the UK. *Food Control*, *22*(8), 1216-1225.

Ministry of Agriculture and Forestry. (2006). Food Act 23/2006. https://www.finlex.fi/fi/laki/smur/2006/20060023. Accessed 31.7.2018.

Ministry of Agriculture and Forestry. (2011). Regulation 1369/2011 on food hygiene in approved food establishments. http://www.finlex.fi/fi/laki/alkup/2011/20111369. Accessed 31.7.2018.

Ministry of Agriculture and Forestry. (2014a). Regulation 795/2014 on food hygiene in approved food establishments. https://www.finlex.fi/fi/laki/smur/2014/20140795. Accessed 31.7.2018.

Ministry of Agriculture and Forestry. (2014b). Regulation 590/2014 on meat inspection. http://www.finlex.fi/fi/laki/alkup/2014/20140590. Accessed 31.7.2018.

Ministry of Agriculture and Forestry. (2018). Lakiluonnos uudeksi elintarvikelaiksi. Luonnos 30.4.2018. http://mmm.fi/documents/1410837/4862866/ELINTARVIKELAKI+uusi+300418.pdf/03634714-c705-4eb7-a0d3-af71e030d064/ELINTARVIKELAKI+uusi+300418.pdf.pdf. Accessed 31.7.2018.

Ministry of Justice. (2003). Administrative Procedure Act 434/2003. https://www.finlex.fi/fi/laki/smur/2003/20030434. Accessed 31.7.2018.

Morin, D. (2001). Influence of value for money audit on public administrations: Looking beyond appearances. *Financial Accountability & Management*, *17*(2), 99-117.

Morin, D. (2004). Measuring the impact of value-for-money audits: a model for surveying audited managers. *Canadian Public Administration*, *47*(2), 141–164.

Motsoaledi, A. (2018). Media statement by the Minister of Health Dr Aaron Motsoaledi regarding the update on the Listeriosis outbreak in South Africa. http://www.nicd.ac.za/wp-content/uploads/2018/03/Update-on-Listeriosis-Press-Conference-Monday-04-March-2018-FINAL.pdf. Accessed 31.7.2018.

Mousing, J., Kyrval, J., Jensen, T. K., Aalbæk, B., Buttenschøn, J., Svensmark, B., & Willeberg, P. (1997). Meat safety consequences of implementing visual postmortem meat inspection procedures in Danish slaughter pigs. *Veterinary Record*, *140*(18), 472-477.

Muth, M. K., Fahimi, M., & Karns, S. A. (2009). Analysis of *Salmonella* control performance in U.S. young chicken slaughter and pork slaughter establishments. *Journal of Food Protection, 72*(1), 6-13.

Nastasijević, I., Lakićević, B., & Petrović, Z. (2017). Cold chain management in meat storage, distribution and retail: a review. *IOP Conference Series: Earth and Environmental Science, 85,* 1-10.

National Audit Systems Network. (2014). Auditing effectiveness of official control systems. https://audit-network.wikispaces.com/Auditing+Effectiveness+of+Official+Control+Systems. Accessed 31.7.2018.

Nel, S., Lues, J. F. R., Buys, E. M., & Venter, P. (2004). The personal and general hygiene practices in the deboning room of a high throughput red meat abattoir. *Food Control*, *15*(7), 571-578.

Nestor, F., & Hauter, W. (2000). The jungle 2000: Is America's meat fit to eat? Public Citizen. http://www.dethronedelay.org/documents/TheJungle2000.PDF. Accessed 31.7.2018.

Netherlands Food and Consumer Product Safety Authority. (2013). Risk-based application of tasks of the official veterinarian and official auxiliaries in small and medium-sized slaughterhouses for poultry and lagomorphs in the Netherlands. Final Report, 01-08-2013.

Nevas, M., Kalenius, S., & Lundén, J. (2013). Significance of official food control in food safety: Food business operators' perceptions. *Food Control, 31*(1)*,* 59-64.

Newbold, K. B., McKeary, M., Hart, R., & Hall, R. (2008). Restaurant inspection frequency and food safety compliance. *Journal of Environmental Health*, *71*(4), 56-61.

Nielsen, A. (2006). Contesting competence—Change in the Danish food safety system. *Appetite*, *47*(2), 143-151.

Nørrung, B., & Buncic, S. (2008). Microbial safety of meat in the European Union. *Meat Science, 78*(1-2), 14-24.

Osés, S. M., Luning, P. A., Jacxsens, L., Santillana, S., Jaime, I., & Rovira, J. (2012). Food safety management system performance in the lamb chain. *Food Control*, *25*(2), 493-500.

Pacholewicz, E., Barus, S. A. S, Swart, A., Havelaar, A. H., Lipman, L. J. A., & Luning, P. A. (2016). Influence of food handlers' compliance with procedures of poultry carcasses contamination: A case study concerning evisceration in broiler slaughterhouses, 68, 367-378.

Pearce, R. A., Bolton, D. J., Sheridan, J. J., McDowell, D. A., Blair, I. S., & Harrington, D. (2004). Studies to determine the critical control points in pork slaughter hazard analysis and critical control point systems. *International Journal of Food Microbiology*, *90*(3), 331-339.

Pennington, H. (2009). The public inquiry into the September 2005 outbreak of *E. coli* O157 in South Wales.

http://gov.wales/docs/dhss/publications/150618ecoli-reporten.pdf. Accessed 31.7.2018.

Pinillos, R. G., & Jukes, D. J. (2008). Hygiene assessment system (HAS) scores – An analysis of the available data from English slaughterhouses. *Food Control*, *19*(8), 806-816.

Piras, F., Fois, F., Mazza, R., Putzolu, M., Delogu, M. L., Lochi, P. G., Pani, S. P., & Mazzette R. (2014). *Salmonella* prevalence and microbiological contamination of pig carcasses and slaughterhouse environment. *Italian Journal of Food Safety*, *3*(4), 4581.

Pope, S., Bukowski, G., & Beckett, A. (2013). Slaughterhouse social science research project. Ipsos Mori. Social Science Research Unit, Food Standards Agency, February 2013, Unit Report 18. https://www.food.gov.uk/sites/default/files/795-1-1408_FS145004_-_Social_Science_in_Slaughterhouse_0.pdf. Accessed 31.7.2018.

Powell, D. A., Erdozain, S., Dodd, C., Costa, R., Morley, K., & Chapman, B. J. (2013). Audits and inspections are never enough: A critique to enhance food safety. *Food Control*, *30*(2), 686-691.

Powell, D. A., Jacob, C. J., & Chapman, B. J. (2011). Enhancing food safety culture to reduce rates of foodborne illness. *Food Control, 22*(6), 817-822.

Rahkio, M. (2009). Lihantarkastuksen kehittämistarpeet: Selvityshenkilö Marjatta Rahkion raportti ja ehdotukset, Helsinki. http://mmm.fi/documents/1410837/1801176/Lihantarkastusten-kehittamistarpeeti.pdf/df8ca8d0-72b1-4f2d-ab87-92fd4f4cb34b. Accessed 31.7.2018.

Rahkio, M. (2010). HACCP in poultry slaughterhouses. In I. Guerrero-Legarreta (Ed.), Handbook of Poultry Science and Technology, 1 : Primary Processing. (pp. 667-682). John Wiley & Sons, Inc.

Rahkio, M., & Korkeala, H. (1996). Microbial contamination of carcasses related to hygiene practice and facilities on slaughtering lines. *Acta Veterinaria Scandinavica*, *37*(3), 219-228.

Rahkio, M., & Korkeala, H. (1997). Airborne bacteria and carcass contamination in slaughterhouses. *Journal of Food Protection*, *60*(1), 38-42.

Rahkio, M., Uutela, A., & Korkeala, H. (1995). Motivation and characterization of Finnish meat inspection veterinarians. *Acta Veterinaria Scandinavica*, *36*(4), 563-570.

Ramalho, V., Pinto de Moura, A., & Cunha, L. M. (2015). Why do small business butcher shops fail to fully implement HACCP? *Food Control*, *49*, 85-91.

Reske, K. A., Jenkins, T., Fernandez, C., VanAmber, D., & Hedberg, C. W. (2007). Beneficial effects of implementing an announced restaurant inspection program. *Journal of Environmental Health*, *69*(9), 27-34.

Riedl, R., & Riedl, C. (2008). Shortcomings of the new European food hygiene legislation from the viewpoint of a competent authority. *European Food and Feed Law Review*, *3*(2), 64-83. Retrieved from http://heinonline.org/HOL/Page?handle=hein.journals/effl2008&div=17&g_sent=1&casa_token=&collection=journals.

Robbins, J. T. (2000). A study of the relationship between skill variety and high internal work motivation, task identity and high internal work motivation, task significance and high internal work motivation, autonomy and high internal work motivation and intrinsic job feedback and high internal work motivation in the manufacturing arena (PhD thesis). Nova Southeastern University.

Rusconi, G. (2016). Food Safety and Policy in the European Union. In: G., Steier, & K., Patel (eds.), *International Food Law and Policy* (pp.451-483). Springer, Cham.

Salas, E., Rosen, M. A., & DiazGranados, D. (2010). Expertise-based intuition and decision making in organizations. *Journal of Management*, *36*(4) (2010), 941-973.

Savage, R. (2014). HACCP. In T. Ninios, J. Lundén, H. Korkeala, & M. Fredriksson-Ahomaa (eds.), Meat inspection and control in the slaughterhouse (pp. 540-551). Chichester, UK: John Wiley & Sons, Ltd.

Schleicher, C., Scheriau, S., Kopacka, I., Wanda, S., Hofrichter, J., & Köfer, J. (2013). Analysis of the variation in meat inspection of pigs using variance partitioning. *Preventive Veterinary Medicine*, *111*(3-4), 278-285.

Scudamore, J. (2002). Origin of the UK Foot and Mouth Disease epidemic in 2001. Department for Environment, Food and Rural Affairs (DEFRA), UK. http://adlib.everysite.co.uk/resources/000/095/936/fmdorigins1.pdf. Accessed 31.7.2018.

Sofos, J. N. (2008). Challenges to meat safety in the 21st century. *Meat Science*, *78*(1-2), 3-13.

Stadlmüller, L., Matt, M., Stüger, H. P., Komericki-Strimitzer, T., Jebousek, K., Luttenfeldner, M., & Fuchs, K. (2017). An operational hygiene inspection scoring system for Austrian high-risk companies producing food of animal origin. *Food Control*, *77*, 121-130.

Stärk, K. D. C., Alonso, S., Dadios, N., Dupuy, C., Ellerbroek, L., Georgiev, M., Hardstaff, J., Huneau-Salaün, A., Laugier, C., Mateus, A., Nigsch, A., Afonso, A., & Lindberg, A. (2014). Strenghts and weaknesses of meat inspection as a contribution to animal health and welfare surveillance. *Food Control*, *39*, 154-162.

Summan, A. (2013). Challenges for Ontario's meat and poultry processing sector. http://www.oimp.ca/wp-content/uploads/2016/09/13-12-01-Challenges-for-Ontarios-Meat-and-Poultry-Processing-Sector.pdf. Accessed 31.7.2018.

Taylor, E. (2001). HACCP in small companies: benefit or burden? *Food Control*, *12*(4), 217-222.

Thompson, S., de Burger, R., & Kadri, O. (2005). The Toronto food inspection and disclosure system: A case study. *British Food Journal, 107*(3), 140-149.

Thompson, D. (2012). Expanding locally sourced beef in Northern Ontario through the co-operative model. http://www.nordikinstitute.com/wp-content/uploads/2012/05/thompsond.final_.pdf. Accessed 31.7.2018.

TNS-BMRB. (2010). Meat hygiene controls and testing. TNS-BMRB report, JN 209445. https://www.food.gov.uk/sites/default/files/multimedia/pdfs/publication/cfsummreportmeathygiene.pdf. Accessed 31.7.2018.

Tomašević, I., Šmigića, N., Đekić, I., Zarić, V., Tomić, N., & Rajković, A. (2013). Serbian meat industry: A survey on food safety management systems implementation. *Food Control*, *32*(1), 25-30.

Toronto Public Health. (2002). Food premises inspection and disclosure system evaluation report. https://www.toronto.ca/health/dinesafe/pdf/food_safety_evaluation.pdf. Accessed 31.7.2018.

Tsola, E., Drosinos, E. H., & Zoiopoulos, P. (2008). Impact of poultry slaughter house modernisation and updating of food safety management systems on the microbiological quality and safety of products. *Food Control*, *19*(4), 423-431.

Tuttle, J., Gomez, T., Doyle, M. P., Wells, J. G., Zhao, T., Tauxe, R. V., & Griffin, P. M. (1999). Lessons from a large outbreak of *Escherichia coli* O157:H7 infections: insights into the infectious dose and method of widespread contamination of hamburger patties. *Epidemiology and Infection, 122*, 185-192.

Tähkäpää, S. (2016). Challenges in implementing food safety legislation. Academic Dissertation, Faculty of Veterinary Medicine, University of Helsinki, Finland. https://helda.helsinki.fi/handle/10138/167253. Accessed 31.7.2018.

Tähkäpää. S., Kaario, N., Maijala, R., Korkeala, H., Tulokas, A., & Lundén, J. (2009). Problems for meat and fish business operators in implementing food law in Finland. *Archiv für Lebensmittelhygiene*, *60*, 172-178.

Tähkäpää, S., Maijala, R., Hörman, A., Poutiainen-Lindfors, U., & Korkeala, H. (2008). Reasons behind inadequate local food control resources. *Food Control*, *19*(4), 403-411.

Uzal, F. A., More, S. J., Dobrenov, B., & Kelly, W. R. (2002). Assessment of organoleptic postmortem inspection techniques for bovine offal. *Australian Veterinary Journal*, *80*(1-2), 70-74.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing and Health Sciences, 15*(3), 398-405.

Viator, C. L., Muth, M. K., Brophy, J. E., & Noyes, G. (2017). Costs of food safety investments in the meat and poultry slaughter industries. *Journal of Food Science*, *82*(2), 260-269.

Violaris, Y., Bridges, O., & Bridges, J. (2008). Small businesses – big risks: current status and future direction of HACCP in Cyprus. *Food Control*, *19*(5), 439-448.

Walker, E., Pritchard, C., & Forsythe, S. (2003). Hazard analysis critical control point and prerequisite programme implementation in small and medium size food businesses. *Food Control*, *14*(3), 169–174.

Waters, A. B., VanDerslice, J., Porucznik, C. A., Kim, J., DeLegge, R., & Durrant, L. (2013). Impact of internet posting of restaurant inspection scores on critical violations. 75(10), 8-12. Retrieved from https://search.proquest.com/docview/1354972326?accountid=11365. Accessed 31.7.2018.

Weatherill, S. (2009). Report of the independent investigator into the 2008 listeriosis outbreak. http://publications.gc.ca/site/eng/361474/publication.html. Accessed 31.7.2018.

Webber, J. J., Dobrenov, B., Lloyd, J., & Jordan, D. (2012). Meat inspection in the Australian red-meat industries: past, present and future. *Australian Veterinary Journal, 90*(9), 363-369.

Weets, K. (2008). How effective are performance audits? A multiple case study within the local audit office of Rotterdam. Paper for the 5th International Conference on Accounting, Auditing & Management in Public Sector Reforms, Amsterdam, 3-5 September 2008. http://steunpuntbov.be/rapport/s2A0206001_Weets_2008_performance_audits_Rotterdam.pdf. Accessed 31.7.2018.

Wegener, H. C. (2010). Danish initiatives to improve the safety of meat products. *Meat Science*, *84*(2), 276-283.

Wells, J. G., Shipman, L. D., Greene, K. D., Sowers, E. G., Green, J. H., Cameron, D. N., Downes, F. P, Martin, M. L., Griffin, P. M., Ostroff, S. M., Potter, M. E., Tauxe, R. V., & Wachsmuth, I. K. (1991). Isolation of

Escherichia coli serotype 0157:H7 and other shiga-like-toxin-*producing E. coli* from dairy cattle. *Journal of Clinical Microbiology*, *29*(5), 985-989.

Wilcock, A., Ball, B., & Fajumo, A. (2011). Effective implementation of food safety initiatives: Managers', food safety coordinators' and production workers' perspectives. *Food Control*, *22*(1), 27-33.

Wilhelm, B., Rajić, A., Greig, J. D., Waddell, L., & Harris, J. (2011). The effect of hazard analysis critical control point programs on microbial contamination of carcasses in abattoirs: A systematic review of published data. *Foodborne Pathogens and Disease, 8*(9), 949-960.

Williams, M. S., & Ebel, E. D. (2012). Estimating changes in public health following implementation of hazard analysis and critical control point in the United States broiler slaughter industry. *Foodborne Pathogens and Disease, 9*(1), 59-67.

Word Health Organization. (2006). Five keys to safer food manual. WHO Department of Food Safety, Zoonoses and Foodborne Diseases. http://www.who.int/foodsafety/publications/consumer/manual_keys.pdf. Accessed 31.7.2018.

Wright, M., Leach, P., & Palmer, G. (2012). A tool to diagnose culture in food business operators. Report from Greenstreet Berman Ltd for the Food Standards Agency, GSB ref: CL2567. https://www.food.gov.uk/sites/default/files/803-1-1430_FS245020.pdf. Accessed 31.7.2018.

Xiong, C., Liu, C., Chen, F., & Zheng, L. (2017). Performance assessment of food safety management system in the pork slaughter plants in China. *Food Control*, *71*, 264-272.

Yapp, C., & Fairman, R. (2006). Factors affecting food safety compliance within small and medium-sized enterprises: implications for regulatory and enforcement strategies. *Food Control*, *17*(1), 42-51.

Yinnas, F. (2009). Food safety culture: Creating a behavior-based food safety management system. Arkansas, USA: Springer Science + Business Media, LLC.