ORIGINAL ARTICLE

Food Safety Hazards and Microbiological Zoonoses in European Meat Imports Detected in Border Inspection in the Period 2008–2013

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Impacts

- International trade enables foodborne pathogens to spread worldwide; therefore, food consignments arriving at external EU borders are strictly controlled and hazardous consignments are refused entry into the European Union.
- These rejected consignments are officially notified to the European Commission's Rapid Alert System for Food and Feed. This study shows the trends and temporal and spatial distribution of notifications on food safety hazards between January 2008 and December 2013.
- Notifications on poultry meat and their products increased exponentially in recent years due to high detection rates of *Salmonella* spp. resulting from larger import volumes and consequently reinforced checks. Other meat consignments such as pork and beef are most often rejected due to findings of shiga-toxin-producing *E. coli*.

Keywords:
Food safety criteria; border control; public health; rapid alert system for food and feed

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Summary

Microbiological contaminations and other food safety hazards are omnipresent within the European Union (EU) and a considerable risk for consumers, particularly in imported meat and meat products. The number of rejections at external EU borders has been increasing in recent years. Official authorities in each member state are therefore obliged to notify border rejections of food and animal feed due to a direct or indirect risk to human or animal health. This study explored the trends and temporal and spatial distribution of notifications on food safety hazards between January 2008 and December 2013 with a special emphasis on microbiological zoonoses in meat and meat products including poultry at border checks resulting from the rapid alert system for food and feed (RASFF). Results indicated that border rejection notifications are increasing exponentially, frequently due to *Salmonella* in poultry and shiga-toxin-producing *E. coli* in meat and meat products.

Introduction

Secure access to safe food and a constant supply of products from all over the world is demanded by European citizens. Facing globalization, meat and meat products of non-European origin are essential to meet consumers' demands for a huge variety of products. In 2013, more than 300 thousand tonnes of beef were imported, mainly from Brazil, Uruguay and Argentina. Poultry meat imports amounted to more than 870 thousand tonnes (2013), mainly from Brazil, dropping to 63% in 2013 from 73% in 2010. Thailand filled the gap and showed an upward trend in this time period from 18% to 28% of total EU poultry meat imports (EC, 2014). Although pork is of high significance for the European meat market, import quantities from third countries remain negligible with 17–20 thousand tonnes in the past decade (EC, 2013). Consistent application of food safety measures between countries as well as within countries can improve international trade and minimize economic burdens worldwide (WHO, 2007).

Food products may circulate freely across all member states once these have entered the communities market.

European Union border inspection posts (BIP) check therefore all documentation and the identity of every single consignment arriving at external borders for legal compliance before these enter the Community, as food safety hazards within these consignments, including microbiological contaminants, do occur regularly. These border controls have a highly elaborated physical testing regime, whereas mandatorily at least each 20% of fresh meat and products including offal of bovine, ovine, caprine, porcine and equine species are tested; 50% of poultry meat and poultry meat products are physically checked (EC, 1994). Additionally, scheduled samples are taken according to the multiannual national control plan (MANCP) systematically and cover risk-orientated feed and food, animal health and animal welfare controls in each member state (Regulation (EC) 882/2004). Non-scheduled samples are taken from suspicious consignments.

Checked consignments can therefore either be released to the European market if they comply with legal regulations or rejected in case of a detected food safety risk, adulteration or fraud. These consignments have to be rejected at all BIPs of the European Union and the European Economic Area (EEA). Notifications on these specific consignments are released immediately to all EU border inspection posts to ensure that rejected products do not re-enter the EU through another BIP. These notifications are distributed simultaneously within the TRAde Control and Expert System (TRACES) and the rapid alert system for food and feed (RASFF).

TRACES is the European network for all local veterinary authorities and created a single central database for monitoring the movements of animals and products of animal origin both within EU and those of non-EU origin. It notifies, certifies and monitors imports, exports and trade of animals and animal products. The TRACES database contains details and the reason for the rejection of a consignment, but it does not imply consequences, measures and interventions (Commission Decision 2003/623/EC).

The rapid alert system on food and feed (RASFF) was already implemented in 1979 to rapidly disseminate alerts and information on direct or indirect human and animal health hazards for traded products already on the common European market. Currently, all EU 28 national food safety authorities, the European Commission, the EFSA, the ESA, Norway, Liechtenstein, Iceland and Switzerland are members. RASFF is hosted by the statistical service of the European Commission (EC, 2002).

Only RASFF notifications enable stakeholders legally to respond immediately to public health hazards and to undertake interventions and measures. These can include withholding, recalling, seizing, rejecting and destroying consignments from the European market regardless of their origin. Ensuring appropriate action as early as possible, the RASFF covers in a holistic approach 36 product categories: food of animal origin such as meat, fishery products and honey; food of non-animal origin such as fruits and vegetables, herbs and spices, beverages for human consumption but also feed and food contact materials. For those products already on the market, RASFF classifies two statuses for market notifications: 'Alerts' are notifications of findings that present serious food safety risks for other members of the RASFF system. The RASFF categories comprise 26 hazards mainly referring to unfitness for consumption such as abiotic and biotic contamination and residues, but, as well those referring to unsuitability for marketing such as incorrect labelling, packaging, adulteration and other illegal manipulations. Alerts are triggered by the notifying member state to initiate immediate action. 'Information' notifications are distributed on findings or measures that may not necessarily have implications for all members as the relevant products have not reached their markets. Two new subtypes of information notification were added in 2011: 'Information notifications for follow-up' are related to a product that is or may be placed on the market in another member country. However, if a product is either present only in the notifying member country or has not been placed on the market or is even no longer on the market, 'information notifications for attention' are distributed based on Regulation (EC) 16/2011 (RASFF, 2011). Any other information related to food and feed safety aspects, which might be of interest, but neither requires alert nor information notifications, is distributed throughout the system as 'news'.

Consignments that have been rejected at European BIPs do not reach the EU market and can consequently never trigger an 'alert' or 'information' notification. RASFF did not cover information on rejections of consignments at external borders of the EU at its outset. Yet, it has been frequently used for this purpose, and following this, border rejection notifications were set as a distinct classification in 2008. An interface between TRACES and RASFF was established to distribute information on border rejections from within TRACES (RASFF, 2010).

In contrast to TRACES, RASFF features a public, interactive online portal with a searchable RASFF database. It provides free access to summary information concerning the most recently transmitted RASFF notifications as well as information on notification issued in the past.

The objective of this study was to explore the trends and temporal and spatial distribution of border rejection notifications in the pre-defined RASFF categories 'meat and meat products' and 'poultry meat and meat products' on food safety hazards between January 2008 and December 2013

with special emphasis on microbiological zoonoses. 'Alerts' and 'Information' notifications concerning EU-market controls were not included in the analysis.

Material and Methods

Rapid alert system for food and feed (RASFF) border rejection notifications were obtained from the RASFF portal as database for the time period between 01.01.2008 and 31.12.2013. The RASFF categories 'meat and meat products' covering mammalian meat from bovine, ovine, caprine, porcine and equine species and the category 'poultry meat and meat products' referring to avian species such as chicken, turkey, ostrich and other edible poultry were evaluated. The database includes detailed information on each notification, such as the classification and date, hazard category, notifying country and country of origin as well as product type and category. The reference number for border rejection notifications is made up of the current year, followed by a dot and a sequence of three letters (2012.AAA, 2012.AAB, etc.). Alert and information notifications are given a different type of reference number consisting of four digits instead of three letters (e.g. 2012.0001). Each notification subject refers to the laboratory analyses and methods, their results in the specific product type and country of origin. Each notification represents a single case reporting on a health risk detected in one or more consignments of meat and meat products including poultry. These data were compiled and entered into a spreadsheet. Feed and other food stuffs other than meat and meat products including poultry were excluded from analysis. Data analysis was performed with Excel, Microsoft Office 2010. Data were visualized in Excel and Processing 2 as open source integration for Windows.

Results

Border rejection notifications on food safety hazards with special emphasis on microbiological zoonoses in the RASFF categories 'meat and meat products' and 'poultry meat and meat products' according to the rapid alert system for food and feed (RASFF) showed a consecutive increase over a time period from January 2008 to December 2013. Whereas the growth in notifications on 'meat and meat products other than poultry' was rather linear, the growth in notifications on poultry meat and poultry meat products moved exponentially from 2011 onwards, resulting in 106 border rejections in 2013 (Fig. 1).

RASFF category 'Meat and meat products'

A total of 2071 notifications on meat and meat products were received between 01.01.2008 and 31.12.2013, classified into 909 alerts, 665 information, 120 information for attention, 134 information for follow up and 243 border rejections. These 243 border rejections notified for meat and meat products other than poultry were classified into hazardous categories as follows: residues from veterinary medical products ($n = 59$), organoleptic adverse effects ($n = 49$), adulteration or fraud ($n = 24$) and defective or incorrect packaging ($n = 12$), parasitic infestation ($n = 6$), incorrect labelling ($n = 2$) and biocontaminants such as insects ($n = 1$). The category 'Pathogenic micro-organisms' ($n = 78$) represented one-third of all notifications (33.6%), and mainly contained notifications on shiga-toxin-producing *Escherichia coli,* followed by *Salmonella* spp. and one single notification on *Listeria monocytogenes* in frozen beef from Uruguay (Fig. 2).

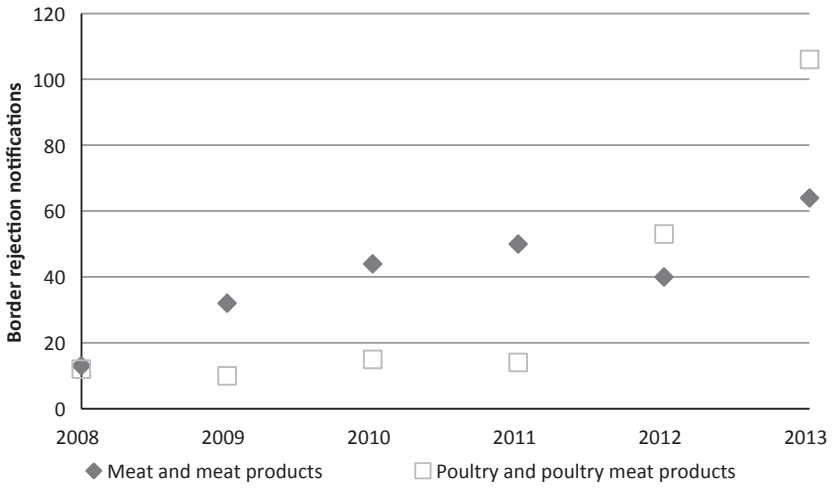

Fig. 1. Development of rapid alert system for food and feed (RASFF) border rejection notifications on 'meat and meat products' and on 'poultry meat and poultry meat products' between January 2008 and December 2013.

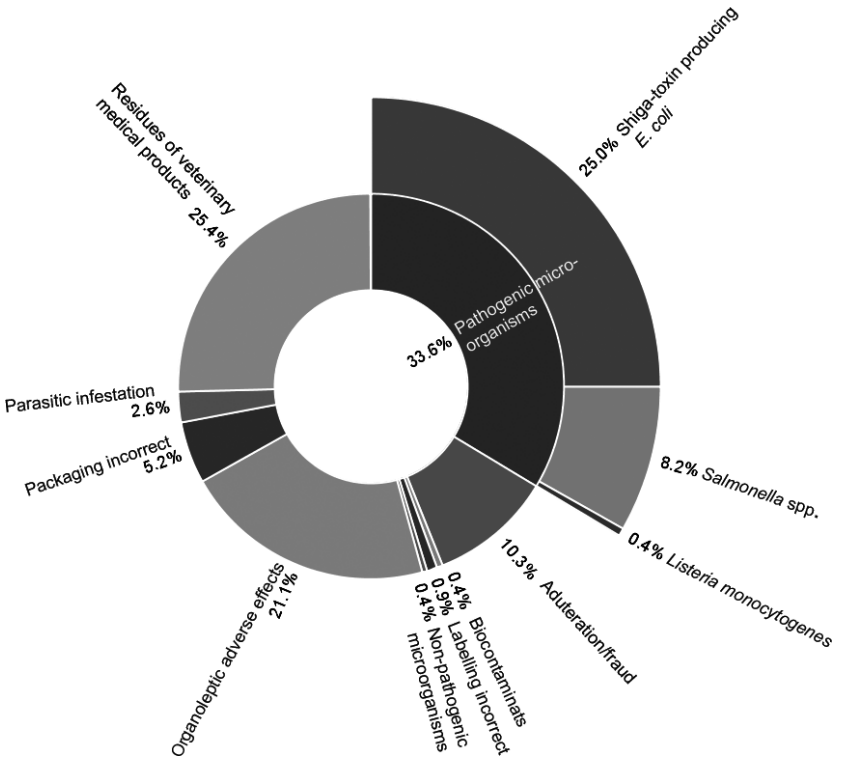

Fig. 2. Distribution of food safety hazards in meat and meat products other than poultry in border rejections (%).

The increase in border rejection notifications in 2013 in 'meat and meat products' was entirely due to findings of shiga-toxin-producing *E. coli*, strongly connected with beef. Most border rejections concerning pathogenic microorganisms for chilled beef were reported from Argentina and Brazil. The shiga-toxin-producing *E. coli* and *Salmonella* originating from Argentina and Brazil were exclusively reported on beef and beef products. Namibia reported shiga-toxin-producing *E. coli* in beef products and in game (springbok) likewise. Border rejection notifications on beef from Uruguay mainly concerned shiga-toxin-producing *E. coli*; one notification was received on *Listeria monocytogenes*. Six notifications were received on *Salmonella* spp. from Uruguay (Fig. 3). One border rejection notification was reported on *Salmonella* spp. in frozen kangaroo meat from Australia, in frozen sausages from the United Kingdom, in bovine meat from New Zealand, in frozen beef cuts from Swaziland and in chilled frog legs from Turkey, respectively.

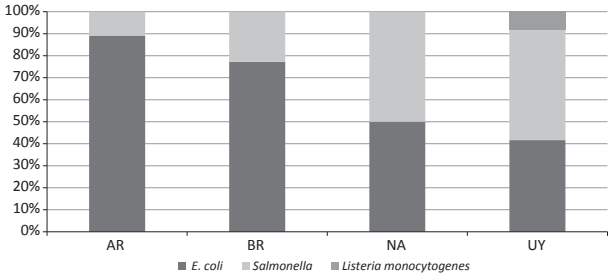

Fig. 3. Notified microbiological hazards in the rapid alert system for food and feed (RASFF) category 'meat and meat products' in percentage and per country between 2008 and 2013 in border rejections.

RASFF Category 'Poultry meat and poultry meat products'

A total of 1350 notifications on poultry meat and poultry meat products were received between 01.01.2008 and 31.12.2013, classified into 436 alerts, 564 information, 94 information for attention, 46 information for follow-up and 210 border rejections. These 210 border rejections were classified into hazard categories as follows: residues from veterinary medical products (n = 49), organoleptic adverse effects (n = 26), adulteration or fraud (n = 8) and defective or incorrect packaging (n = 4), biocontaminants such as insects (n = 2) and heavy metals (n = 1). Pathogenic microorganisms (n = 126) represented more than half of all border rejection notifications (58%) and were almost exclusively characterized by notifications on *Salmonella* spp. One single border rejection notification was received for *Listeria monocytogenes* in frozen chicken breast filets from Argentina (Fig. 4).

Border rejection notifications on *Salmonella* spp. in poultry were principally related to products from Brazil. Of

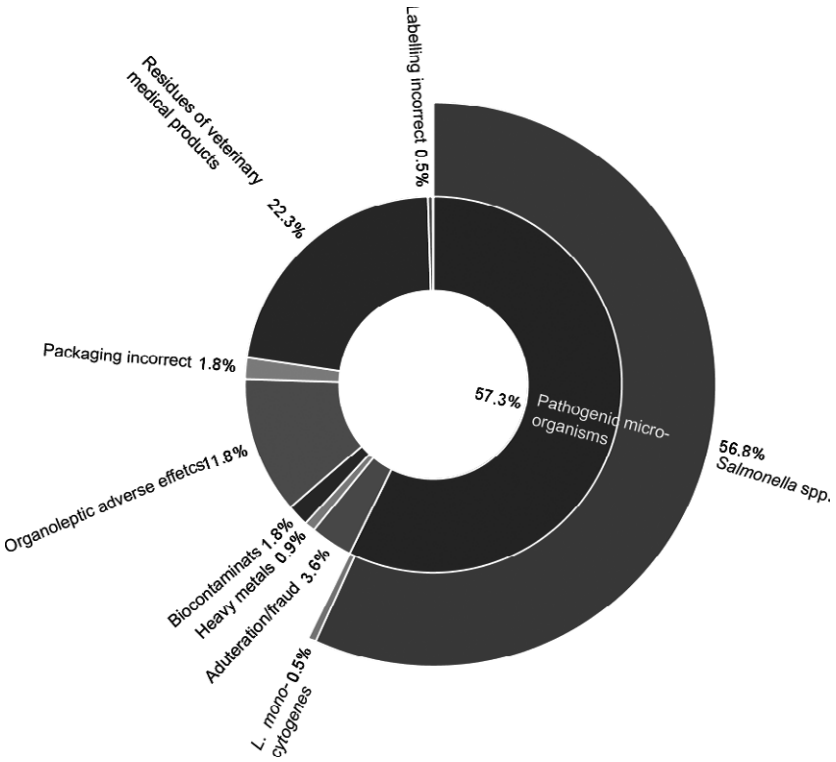

Fig. 4. Distribution of food safety hazards in poultry meat and poultry meat products in border rejections (%).

119 border rejection notifications on *Salmonella* spp. from Brazil, 67 notifications concerned chicken meat and their products, 26 notifications turkey meat and their products and 26 notifications were not specified, referring to poultry meat in general. The distribution over time showed a strong increase with 98 border rejection notifications received in 2013 compared to the previous years, which were marked by low notification rates of two (2) in 2009 and 2010, three (3) in 2008 and 2011, and 11 border rejection notifications in 2012 (Fig. 5). Five border rejections concerned *Salmonella* spp. in chicken breast from Argentina, and one notification was received on *Salmonella* spp. in turkey breasts from Israel.

Discussion

International meat trade is essential to meet the demand of global markets and consumers expect a non-stop supply of products from all over the world. Production of safe food is primarily the responsibility of the food industry, yet countries are urged to develop transparent regulations and other measures based on the risk analysis to ensure a safe food supply from production to consumption. In line with the guidance of the Codex Alimentarius Commission and other relevant international standard-setting bodies, coherent legislative food safety standards are met in all adopting countries (WHO, 2007). Nonetheless, imported meat and meat products pose a considerable risk for consumers in the European Union as zoonotic agents spread worldwide within the complex international trading system. International guidelines for microbiological criteria in respect to many foodstuffs have not yet been established. Therefore, microbiological criteria for the community were laid down in Regulation (EC) 2073/2005 amending the Codex Alimentarius guideline 'Principles for the

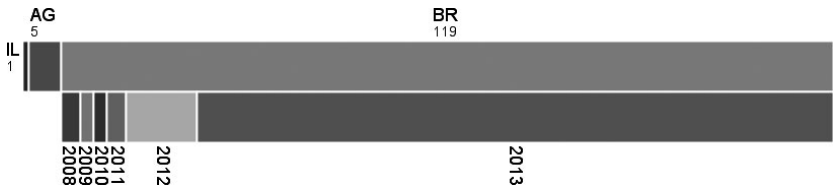

Fig. 5. Border rejection notifications on *Salmonella* of 'poultry meat and poultry meat products' from Argentina (AG), Israel (IL) and Brazil (BR), Brazil with its notification distribution between 2008 and 2013.

establishment and application of microbiological criteria for foods CAC/GL 21 — 1997' and the advice of the Scientific Committee on Veterinary Measures relating to Public Health and the Scientific Committee on Food.

International perspective

Although pork meat amounts to half of the per capita consumption within the European Union imports, are, however, expected to remain within the range of 20 thousand tonnes in the next years like in 2013. Poultry meat still makes up about 50% of the annual per capita consumption in the EU, and poultry meat imports increased by 13 thousand tonnes in 2013 with lower volumes from Brazil due to production constraints (-10%), compensated by doubled imports from Thailand compared to 2012, which has been given sanitary acceptance of raw poultry meat since July 2012 (EC, 2013). Whereas beef showed a downward trend with 18.8% in 2013 (EC, 2013, 2014), the EU beef imports in 2013 from third countries were expected to be up more than 10% on figures in 2012 due to increased shipments mainly from Brazil and Uruguay (EC, 2013). The ongoing recovery of beef production in Argentina still limited their export volumes. The overall trade flows in beef imports are expected to continue with +5% in 2014 (EC, 2013).

The United States represents a counterpart to the EU regarding import volumes. Official U.S. authorities carry out preventative strict certifications and inspection systems are implemented in exporting countries. The Food and Drug Administration (FDA) of the United States is authorized to detain a regulated product that appears not to comply with legal regulations. The FDA District Office then issues a 'Notice of FDA Action' specifying the nature of the violation to the owner or consignee allowing them to respond to this violation. If the owner fails to submit evidence that the product is in compliance or fails to submit a plan to bring the product into compliance, FDA then issues a further 'Notice of FDA Action' refusing admission of the product. The product then has to be exported or destroyed within 90 days. The United States Import Refusal Report (IRR) determines those products that are refused. The IRR is generated from data collected by FDA's Operational and Administrative System for Import Support (OASIS) and is updated monthly (Buzby et al., 2008). Generally, there have only been very few isolated incidents of meat including poultry being rejected in the last decade, presumably due to the pre-certifications and specific U.S. food safety legislation for meat and poultry. Yet, the published data only cover meat and poultry products already regulated by the FDA (Buzby and Roberts, 2010). A transatlantic treaty would change the procedure and developments for RASFF in future.

Border rejection notifications

At its outset in 1979, RASFF was not intended to cover information on EU border rejections, yet it has been frequently used for this purpose. In 2008, border rejection notifications were set as a distinct classification, which amounted in the following year to more than 50% of all RASFF notifications being triggered as border rejections (Petroczi et al., 2010; RASFF, 2010). The greater demand of high-quality meat products from a growing EU population is leading to an increased meat import and therefore due to the given frequency of physical controls to more border checks in proportion (EC, 1994). In 1992, the establishment of the EU internal market obliged all member states to share information on local food-safety incidents in order to facilitate other national control services in taking action. Additionally, the EU faced several crises in these years, cumulating in the BSE crisis in 1995 which shaped and changed the functioning of RASFF. These developments, improved electronic communication systems and the creation of national contact points as a single dedicated organisation to contact in case of a serious RASFF alert, greatly reduced the time needed to address such alerts and strengthened RASFF significantly. Cooperation went beyond the strict implementation of a legal act and provided opportunities for mutual help. Benefitting especially from the interface between the single EU BIPs, border hopping of consignments that were once refused to enter the community at one BIP is nowadays not possible (EC, 2009). The continuous growth in notifications reported by particular member states represents the trading volumes of these member states but does not indicate a disastrous food safety situation, although practices and contributions between member states regarding notification do vary (Taylor et al., 2013). In contrast to the last decade, the exponential growth in 'poultry meat and poultry meat products' is related to the amended regulation (EC) 2073/2005 (EC, 2005) and more results on microbiological criteria, especially on *Salmonella* spp. have been recorded (Kleter et al., 2009). The disproportionately strong growth in the number of border rejections coincides with the implementation of a new module for reinforced checks (REC) in 2012. A REC regime can be triggered if a consignment presented for import at the EU borders is refused entry due to an identified serious risk or a recurrent hazard relating to a particular operator in an exporting country. The Council Directive 97/78/EC stipulates certain requirements for REC: a triggered REC obliges all member BIPs to hold and sample the following ten consignments presented of the product in question from the same origin. The consignments are only released on the market when favourable analytical results are obtained. If all ten consignments lead to favourable results, the REC is lifted. However, if one or

more consignments lead to unfavourable results, another series of REC for the next ten consignments is started. Border rejections therefore constitute the largest proportion of all notifications, and with a 40% increase compared to 2012, an all-time-high concerning border rejection was reached in 2013 (RASFF, 2014). Additionally, the notification figures are biased due to the REC regime as this is applied only to predisposed food operators and predictably leads to higher notification rates. Although RASFF is not meant to gather representative figures, but rather emphasizes risk-based analysis, the number of applied REC regimes clearly demonstrates persistent problems in exporting countries (EC, 1994; RASFF, 2014).

Pathogenic microorganisms

Rapid alert system for food and feed (RASFF) notifications on pathogenic microorganisms were frequently reported on major microbiological food safety hazards such as *Salmonella*, *E. coli* and *Listeria monocytogenes,* which are currently under Regulation (EC) 2073/2005 (EC, 2005). Particularly, these foodborne diseases are of high significance for public health as morbidity and mortality are still high. More than 90 000 cases of human salmonellosis are reported every year in the EU, and this causes a significant economic burden of an estimated 3 billion euros every year (EFSA, 2014). Therefore, food safety is of global priority and it is imperative for every country to ensure compliance and appropriate testing of their products.

Salmonella is commonly found in the intestines of healthy birds and mammals and may be transmitted by contaminated foodstuffs such as eggs and raw meat from pigs and poultry. Notifications on *Salmonella* in 'poultry meat and poultry meat products' tripled and increased exponentially from 2011 to 2013. Half of these notifications were border rejections and the vast majority concerned consignments from Brazil. These results might be most likely biased by the implementation of a *Salmonella* food safety criterion in fresh poultry on 1 December 2011 and reinforced checks for several Brazilian food operators by TRACES (RASFF, 2012). In 2012, notifications in meat and meat products' on *Salmonella* from Sweden increased significantly, deriving from other member states for which Sweden enjoys special guarantees under Regulation (EC) 1688/2005. Notifications on *Salmonella* spp. in other food categories were predominantly found in 'fruits and vegetables', particularly for paan leaves from Bangladesh and to a lesser degree for herbs and spices and for animal feed (RASFF, 2011), underlining the impact of fresh products on microbiological food safety (Van Boxstael et al., 2013). As well, bivalve molluscs and cephalopods were frequently notified for *Salmonella*. In 2012, repeated findings of *Salmonella* in frozen squid from Indonesia occurred, 14 notifications also being reported in Italy regarding the same operator, culminating in a REC regime in TRACES. Although more notifications on *Salmonella* have been triggered than ever in recent years, incidents of human Salmonellosis are decreasing (EFSA, 2014). Therefore, consistent and stringent testing regimes applied and notified by RASFF seem to efficiently reduce the number of hazardous products on the market, not only for meat and meat products (Morris et al., 2012).

Escherichia coli counts are indicators of hygienic processing conditions, yet pathogenic *Escherichia coli* bacteria usually lead to fever, diarrhoea and abdominal cramps, whereas shiga-toxin-producing enteropathogenic *E. coli* harbour the potential for causing serious harm to consumers as an infection can lead to the haemolytic uremic syndrome in humans, kidney failure and may be fatal. The main source of such strains is beef, and faecal contamination of the meat occurs most likely during processing at the abattoir. Consuming or handling faecally contaminated food or water, raw and unpasteurised milk and cheese, undercooked beef and vegetables such as sprouts, spinach and lettuce are main risk factors for an infection with pathogenic *E. coli* (EFSA, 2014). Most border rejection cases concerning pathogenic microorganisms for chilled beef were reported for Argentina and Brazil and were placed under reinforced checks through TRACES. As faecal contamination of the meat during processing at abattoirs is unavoidable, especially hazardous contaminated products are therefore withdrawn from the market. In the other RASFF categories, cases of *Escherichia coli* are frequently reported in live bivalve molluscs, indicating poor harvesting water. Additional washing steps can limit the exposure for consumers. The *E. coli* outbreaks in 2011 emphasized the role of products of non-animal origin such as sprouts and vegetables (RASFF, 2010).

Countries with a focused trading structure on certain meat products have an established narrowed set of notified hazards; countries with a wide range of products have as well a wide range of notified hazards. Certain pathogenic microorganisms are strongly associated with certain meat products (*Salmonella* with poultry meat, *E. coli* with beef) and therefore reported more frequently originating from certain countries. RASFF highlights this ongoing risk as well for other products (Alam, 2013).

Although *Listeria monocytogenes* is the least frequently reported pathogenic microorganism in 'meat and meat products', raw and undercooked consumption of high-quality beef is very common. Consequently, notifications have decreased for *Listeria monocytogenes* in recent years, and this pathogen is reported mainly for fish, mostly in salmon and trout. In 2008, Italy regularly notified detection of *Listeria monocytogenes* in smoked salmon, but as most of these notifications did not report a level exceeding legal

regulations they did not trigger an alert (EC, 2005). However, particularly those ready-to-eat foods that are consumed without any further preparation and processed fish, which are not heated before eating, may pose a significant risk.

Rapid alert system for food and feed (RASFF) reports usually to large consignments with considerable trade value. Sampling is carried out either according to 94/336/ECC or risk based due to reasonable suspicion. The analysis of microbiological criteria for products placed on the communities market is therefore carried out rigorously due the given requirements set in Regulation (EC) 2073/2005 and performed according to ISO protocols by accredited laboratories. Particularly in international trade, the strict compliance to these established procedures is essential to ensure that results and initiated legal proceedings become finally res judicata, valid and legally binding for the responsible trading partner. Resulting from this, results obtained on criteria not covered by the Regulation 2073/2005 may not be justifiable at court and initiate difficulties between the trade partners. This is the main reason that no other bacteria are reported than *Salmonella*, *E. coli* and *Listeria monocytogenes*, which are currently covered under Regulation (EC) 2073/2005.

Future work

With an exponential rise in recent years, more food safety hazards than ever have been detected. The efficiency of RASFF to date has avoided serious harm to consumers in Europe. The RASFF system has responded to and mitigated several serious foodborne outbreaks in recent years such as dioxin and *E. coli* crises. Nonetheless, enhanced reporting systems will enable authorities to better target their sampling regime and analysis. The RASFF system already collaborates with different networks and warning systems focused on emerging risks. One of the latest improvements is the 'iRASFF' online notification platform, which responds faster and more efficiently between member states than beforehand. Although classic microbiology performed with official ISO methods is crucial for evaluating viability and infectivity, subsequent strain analyses and results on antimicrobial resistance could benefit epidemiological tracing. For example, pathogenic *E. coli* strains are routinely tested for the genetic marker of virulence genes such as *stx1*, *stx2* or *eae* and are evaluated in molecular biological analysis. Particularly, the multidrug-resistant extended β-lactamase-producing *E. coli* originating from third countries might pose a significant public health threat (Egervarn et al., 2014). Additionally, exchanging the information in a global perspective with the INFOSAN network serves as well as early warning of emerging risks and active precautions worldwide (Savelli et al., 2013).

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References

Alam, S. M. N., 2013: Bangladesh in the Rapid Alert System for Food and Feed notifications in the period 2000–2012: a review. *Vet. Med.* 58, 399–404.

Buzby, J. C., and D. Roberts, 2010: Food trade and food safety violations: what can we learn from import refusal data? *Am. J. Agric. Econ.* 93, 560–565.

Buzby, J. C., L. J. Unnevehr, and D. Roberts, 2008: Safety and imports: an analysis of FDA food-related import refusal reports. *Economic Information Bulletin EIB 39*. U.S. Department of Agriculture, Economic Research Service.

EC, 1994: Comission decision of 20 May 1994 on the reduced frequency of physical checks of consignments of certain products to be implemented from third countries, under Council Directive 90/675/EEC. In: E. Commission (ed.), 94/360/EC. EC, Brussels.

EC, 2002: Regulation (EC) of the Euripean parliament and of the council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food SafetyAuthority and laying down procedures in matters of food safety. In: E. Commission (ed.), 178/2002 Official Journal of the European Communities, Brussels.

EC, 2005: Regulation (EC) 2073/2005 on microbiological criteria for foodstuffs. In: E. Commission (ed.), 2073/2005. Official Journal of the European Union, Brussels.

EC, 2009: The Rapid Alert System for Food and Feed of the European Union: 30 Years of Keeping Consumers Safe. European Commission, Directorate General Health and Consumers, Brussels.

EC, 2013: Short term outlook for the arable crop, meat and dairy markets in the EU for 2013/14. Short Term Outlook. Directorate General for Agriculture and Rural Development, Brussels.

EC, 2014: EU Market Situation for Poultry. Committee for the Common Organisation of the Agricultural Markets. European Commission, Directorate General for Agriculture and Rural Development, Brussels.

EFSA, 2014: The community summary report on trends and sources of zoonoses and zoonotic agents nad food-borne outbreaks in the European Union in 2012. *EFSA J.* 12, 3547.

Egervarn, M., S. Borjesson, S. Byfors, M. Finn, C. Kaipe, S. Englund, and M. Lindblad, 2014: *Escherichia coli* with extended-spectrum beta-lactamases or transferable AmpC beta-lactamases and *Salmonella* on meat imported into Sweden. *Int. J. Food Microbiol.* 171, 8–14.

Kleter, G. A., A. Prandini, L. Filippi, and H. J. P. Marvin, 2009: Identification of potentially emerging food safety issues by analysis of reports published by the European Community's Rapid Alert System for Food and Feed (RASFF) during a four-year period. *Food Chem. Toxicol.* 47, 932–950.

Morris, D. J., A. J. Gray, J. F. Kay, and G. Gettinby, 2012: EU sampling strategies for the detection of veterinary drug residues in aquaculture species: are they working? *Drug Test. Anal.* 4, 1–9.

Petroczi, A., G. Taylor, T. Nepusz, and D. P. Naughton, 2010: Gate keepers of EU food safety: four states lead on notification patterns and effectiveness. *Food Chem. Toxicol.* 48, 1957–1964.

RASFF, 2010: The Rapid Alert System for Food and Feed Annual Report 2009. Rapid Alert System for Food and Feed Annual Report. Health and Consumers Directorate-General of the European Commission, Luxembourg.

RASFF, 2011: The Rapid Alert System for Food and Feed (RASFF) Annual Report 2010. Rapid Alert System for Food and Feed Annual Report. Health and Consumers Directorate-General of the European Commission, Luxembourg.

RASFF, 2012: The Rapid Alert System for Food and Feed Annual Report 2011. Rapid Alert System for Food and Feed Annual Report. Health and Consumers Directorate-General of the European Commission, Luxembourg.

RASFF, 2014: The Rapid Alert System for Food and Feed Annual Report 2013. Rapid Alert System for Food and Feed Annual Report. Health and Consumers Directorate-General of the European Commission, Luxembourg.

Savelli, C. J., B. Abela-Ridder, and K. Miyagishima, 2013: Planning for rapid response to outbreaks of animal diseases transmissable to humans via food. *Rev. Sci. Tech.* 32, 469–477.

Taylor, G., A. Petroczi, T. Nepusz, and D. P. Naughton, 2013: The procrustean bed of EU food safety notifications via the Rapid Alert System for Food and Feed: does one size fit all? *Food Chem. Toxicol.* 56, 411–418.

Van Boxstael, S., I. Habib, L. Jacxsens, M. De Vocht, L. Baert, E. Van de Perre, A. Rajkovic, F. Lopez-Galvez, I. Sampers, P. Spanoghe, B. De Meulenaer, and M. Uyttendaele, 2013: Food safety issues in fresh produce: bacterial pathogens, viruses and pesticide residues indicated as major concerns by stakeholders in the fresh produce chain. *Food Contr.* 32, 190–197.

WHO, 2007: Beijing declaration on food safety. High-level International Food Safety Forum "Enhancing Food Safety in a Global Community". Beijing.