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Chemistry and Food Safety in the EU

The Rapid Alert System for Food and Feed (RASFF)

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The Rapid Alert System for Food and Feed (RASFF)

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Contents

Abbreviations

3-MCPD	3-monochloropropane-1,2 diol
CCP	Critical control point
EEA	European Economic Area
EFSA	European Food Safety Authority
EFTA	European Free Trade Association
EMA	Economically motivated adulteration
EU	European Union
FBO	Food business operator
FSMA	Food Safety Modernization Act
GFL	General Food Law
GMO	Genetically modified organism
HACCP	Hazard analysis and critical control point
HCRI	RASFF border rejection ratio index per hazard category
iRASFF	Interactive Rapid Alert System for Food and Feed
PAH	Polycyclic aromatic hydrocarbons
PCRI	RASFF border rejection ratio index per product category
PIP	Pesticides Initiative Programme
RAPEX	Rapid alert system for non-food consumer products
RASFF	Rapid Alert System for Food and Feed
SO_2	Sulphur dioxide
TSE	Transmissible spongiform encephalopathy
USA	United States of America

Chapter 1
The RASFF: Legal Bases, Aims and Procedures for Notifications

Abstract This chapter provides a general overview of the current food policy in the European Union from the consumers' viewpoint. It describes the European Rapid Alert System for Food and Feed (RASFF) approach on the legal level and with reference to notification procedures. In particular, the chapter explains the definition of original notifications—alerts, border rejection episodes and information 'for follow-up' and 'for attention'—and non-original notifications. The history of RASFF, which had originally been introduced in 1979, is briefly reviewed on the basis of the historical evolution of Food Policy in the European Union and food scares.

Keywords Alert notification · Adulteration · Border rejection notification · European union · Food business operator · Food policy · HACCP · Information for attention · Information for follow-up · RASFF

At present, one the most interesting examples of food safety management is available in the European Union (EU). In general, the current situation in the EU may be considered as the sum of answers provided by EU policy makers to many different food scares since 1980s. Substantially, the European consumer has been continuously and repeatedly hit by different food safety menaces (Knowles et al. 2007); the difference of behaviours in dissimilar cultures and macroeconomic regions of the EU should also be noted when speaking of consumers' reactions. In detail, the analysis of public anxiety factors has to be completed with the examination of the 'food safety risk' problem by different viewpoints, including:

(a) The psychological behaviour of consumers when considering foods and beverages (Knowles et al. 2007). Different feelings may be demonstrated and observed with relation to the same food product category in different moments and for dissimilar brands (Fournier 1998; Oliver 1999). In addition, some confusion concerning specific terms such as 'organic' food may be observed (Barnes et al. 2009)

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(b) The increasing lack of awareness with concern to basic elements of food production (Macias 2008). In fact, the higher the tendency to large-scale productions (with the consequent limitation of access to locally-produced foods and the related experiential knowledge), the lower the number of aware (expert) consumers with basic knowledge of food production activities. In contrast, many people are willing to be more aware of agricultural processes and local food productions (Johnson 2000; Seyfang 2006)
(c) The influence of economic concepts on the idea of food product. In other words, the 'quality/price' ratio is often mentioned by aware and unaware consumers as synonymous of food quality, legality and safety (hygiene). On the other side, many different aspects of the food chain should be considered and carefully analysed, such as the role of food packaging materials and objects and the correlated economic and visual impact on food products (Brunazzi et al. 2014a, b; Parisi 2004, 2012, 2013)
(d) The birth of new communication media with exclusive interests in the ambit of food and beverage. This tendency—the continuous rise of printed and electronic journals and magazines with special interests in food safety—has been observed with the concomitant activity of various pressure groups, scientific institutions and other information media (Berry and McEachern 2005; De Boer et al. 2003). As a result, the rise of public anxiety levels has been continually observed in the EU and other industrialised areas when so-called 'food scandals' have been discovered and reported (Nestle 2013)
(e) Food advertising and correlated marketing strategies with concern to nutrition claims (Choi et al. 2013; Drewnowski and Damon 2005; Drewnowski and Specter 2004; Nestle 2007)
(f) The increasing awareness and correlated responsibilities of food retailers with relation to new and existing regulations. For this reason, the birth of quality management standards such as ISO 9001 norms has allowed food retailers to create a stricter control on food producers and other intermediate players of the food chain. Sometimes, new food-centric quality management systems appear more stringent than current laws (Stilo et al. 2008).

As a result, the transformation of the pre-existing EU food policy in the modern 'consumerist-centered food policy' has been observed in the last decades (Knowles et al. 2007). The definition of a complex system of food-related regulations with mandatory importance (Pisanello 2014a) has to be considered as the current and still unfinished answer of National countries and the EU to food concerns. Substantially, the EU policy has been based on two main pilasters after 1990 (Pisanello 2014a):

- The enforcement of food policy on the one side. This effort concerns a complex group of regulations and norms with the aim of harmonising pre-existing national rules and procedures with relation to the production of food and beverage products

- The implementation of a new consumer policy with a basic goal: the definition of the consumer's viewpoint as the 'barycentre' of food legality, safety and integrity.

This two binaries approach has to be taken into account when considering the nature of EU food policy. In other words, the basis of the whole system of food controls may be theoretically translated with a simple statement: every European consumer should be aware of His/Her role as economic actor when speaking of food and beverage products. This simple concept implies the control of economic actors —food consumers above all—on all individual stages of food production 'from the farm to the fork'. Because of the difficult implementation of this statement in practice, many problems are observed in the current market. However, one basic point has to be always highlighted and guaranteed by the EU viewpoint: food commodities are not simple market products (Pisanello 2014a). Differently from industrial productions, foods and beverages can imply many positive and negative effects on consumers. Consequently, the 'consumers' satisfaction' has to be always guaranteed by means of the promotion of food awareness, in terms of needed information. These information can be nutritional labelling, food origin, evaluation of durabilities, absence or presence of food allergens and genetically modified organisms (GMO), nutritional advices based on the so-called 'Mediterranean Diet' model, etc. (Barbieri et al. 2014a, b; Delgado et al. 2016; Parisi 2002a). In addition, the evaluation of food and beverage products has to take into account the 'thorny' concept of food risk. This term means and implies all possible negative effects on consumers' health, while psychological damages are not apparently considered on the same level. The problem of risk evaluation is correlated with the same concept of food technology: consumers cannot fully understand implications of food processes and strategies on the composition and the definition of food product. This lack of knowledge should be excusable because a sufficient competence in food science should require years of specialised study in a number of interconnected disciplines including at least chemistry and biology. For this reason, the 'Hazard Analysis and Critical Control Point' (HACCP) has been promoted and practically recommended in the EU as the basic tool for evaluating food risks and managing them until related consequences are judged sufficiently low (Delia et al. 2008a; Gurnari 2015; Parisi et al. 2015; Unnevehr and Jensen 1999).

The evaluation of foods and beverages as potentially dangerous goods has to be discussed in terms of microbiological, chemical and physical risks (Andreis and Ottaviani 2002; Barbieri et al. 2014b; Parisi 2002b; Parisi et al. 2004; Stilo et al. 2008). The proactive and preventive nature of food security systems should also be highlighted with relation to HACCP principles (Knowles et al. 2007). The basic problem of risk evaluation is the multiformity of possible negative events, in terms of direct and indirect cause, the geographical localisation of accidents and interested subject(s). From the first viewpoint, risks are classified by means of a tripartite system:

(1) Microbiological risk. It included all possible microbiological menaces (pathogen microorganisms, degradative bacteria, viruses, etc.). This part of the so-called risk evaluation is based on a notable portion of scientific literature on the argument
(2) Chemical risk. This portion of the risk evaluation concerns new and old menaces to consumers' health. Because of the growing number of chemical analytes and correlated health implications, the chemical risk should be considered as the 'evolutive frontier' of food risk analysis
(3) Physical risk. Actually, these words imply the presence of undesired and macroscopic or microscopic non-edible matters into foods and beverages. Usually, physical risks are correlated with the detection of glass, plastics or metallic fragments into packaged or unpackaged commodities.

Each risk is evaluated by means of two risk factors: risk importance or seriousness on the one side (it is generally considered on the basis of the medical scientific literature) and risk probability. The last factor is partially manageable into the food chain. Based on the risk assessment and the definition of preventive and corrective action plans, the risk probability can be lowered.

The localisation of food-related accidents is a very intriguing and complex matter. In fact, all possible risks can be originated into food processing plants, during the transportation, after the final distribution (to mass retailers or final consumers) or in other occasions (catering services, etc.). Virtually, there are a number of possible situations, and every risk has to be classified first with relation to the cause (or causes); the second element (localisation) may determine the effect (in terms of increased or decreased probability).

Finally, the interested person or community has to be carefully evaluated. With specific relation to certain microbiological contaminations with lethal implications, effects are maximised when elderly subjects or immune-compromised people are interested. *Listeria monocytogenes* appears one of the most known examples in the food field (Centers for Disease Control and Prevention 2013; Farber and Peterkin 1991). In other non-food ambits (with food catering services), the presence of *Legionella pneumophila* can hit immune-compromised subjects and cause death episodes into hotels and similar structures (Ahmed 2012; Delia et al. 2008b; Nichols et al. 2000; Tranter 2002).

The next 'step' in the evaluation of food risks (and scandals) is the problem of frauds. This risk is naturally determined by an anthropic factor: the intentional adulteration of foods and beverages by food operators with the aim of gaining economic advantages. In detail, the so-called 'economically motivated adulteration' (EMA) in the broad sector or edible goods for human consumption can be performed in a number of ways and cause many different health incidents (Everstine et al. 2013). Generally, EMA events appear to be correlated with the economic cost of certain expensive ingredients and the intentional substitution of these raw materials with undeclared (different) food materials. However, this way is only one of the many possible varieties: at present, the following EMA episodes and general food frauds can be identified as follows (the list cannot be fully exhaustive) for

classification purposes (Barnes 1996; Everstine et al. 2013; Pointing and Teinaz 2004; Spink et al. 2013):

(a) Substitution of fine and expensive food ingredients with other dissimilar raw materials, including additives (food colourants, etc.). The substitution is not declared and is clearly in contrast with labelled information; in addition, nutritional data can be altered and correlated analyses may give strange but similar results if compared with declared information. The main difficulty is the real assessment of chemical adulteration and microbiological contamination. By the analytical viewpoint, food fraud is extremely important: it is a criminal and intentional act and is generally carried out with the aim of evading detection in foods and beverages
(b) Substitution of fine and expensive food ingredients with the same type or sub-typology of raw materials, with the exclusion of food additives and similar chemicals, or peculiar processes (including 'Halal' and 'Kosher' traditions). The substitution or process modification, also named counterfeiting, is not declared but the general definition of food product is not apparently modified. However, should the product be placed on the market with peculiar origin or provenance claims and related cost be really lower than expected, the economic advantage of adulteration would be understandable. In addition, certain adulterated products can be placed on the market with claims concerning peculiar production methods. Should adulteration be performed, the process or part of the complete production process would be carefully controlled. Anyway, modifications are clearly in contrast with labelled information; in addition, nutritional data can be altered and correlated analyses may give strange but similar results if compared with declared information. It has been reported that illegally imported food commodities can be used for substitution purposes (Pointing and Teinaz 2004)
(c) Reworking of perishable but already expired food products (packaged and unpackaged commodities) with the consequent re-packaging and the definition of new (unreal) shelf life dates. New (expired) food products enter the food chain. Naturally, serious public health results have to be expected
(d) Use of perishable but already expired food products (packaged and unpackaged commodities) and raw materials as food additives in variable percentages. Consequently, food products would contain variable amounts of contaminated and unedible ingredients. The definition of new (unreal) shelf life dates should be equal to the durability of normal food products without expired materials; anyway, serious public health results have to be expected.

Known food frauds episodes appear to be found in large geographical areas: the 'horse meat scandal' has concerned many EU Countries. On the other hand, it has also been reported that certain situations can concern only specific sectors of the whole food chain such as the market of frozen foods instead of refrigerated commodities (O'Mahony 2013). Moreover, the main concern appears now linked to risk consequences: in other terms, the 'old' concept of food adulteration is based

generally on the economic advantage, but the possible introduction of public health risks has been linked recently with declared terrorism acts (Spink and Moyer 2011; Spink et al. 2013).

For these and other reasons, food frauds are one of the most important concerns in the food sector. The importance is equally recognised by Official Institutions (National Organisations, the EU, etc.) on the one side and by food operators, mass retailers above all, with the obvious inclusion of the 'barycentre' of food legality, safety and integrity: the normal consumer. Practically, the management of EMA risks may be difficult. On the one side, food authentication should not be considered in the HACCP strategy; on the other hand, it is surely important when speaking of quality management because of its intrinsic nature of prerequisite program (Spink 2014). In practice, food operators should evaluate EMA risks in a proactive way, similarly to official Inspectors; moreover, this competitive approach against criminal fraudsters would help food and drink industries when speaking of food controls on purchased (and possibly adulterated) commodities. In other words, food operators should work as the first-level monitoring agent, while Official Institutions would follow them with more incisive actions.

1.1 The Road to RASFF: Historical Notes and Current Notification Procedures

Historically, the EU approach to the food and beverage sector cannot be different from the general adopted strategy for the internal market. In general, intra-European trades have to be guaranteed free from all possible protection measures by one or more EU Country. This assurance concerns foods, non-food products, economic resources, services and people (Chen 2004; Duina 2006; McCormick 2014; Pisanello 2014a, b).

One of the most important steps in the EU regulatory is certainly the issue of the Council Directive 92/59/EEC of 29 June 1992, repealed by Directive 2001/95/EC (European Parliament and Council 2001). This directive concerned the creation and the implementation of a compulsory system for the protection of consumers' health and safety. In addition, the internal EU market had to be monitored with the aim of assuring above-mentioned basic principles on free trade (Pisanello 2014a). Substantially, the directive would consider the safety of different products, including foods, when the absence of specific regulations was evident. However, this regulatory instrument had not specifically been written for the complex field of food and beverage products. A more specific document was needed: the framework Regulation (EC) No 178/2002 (European Parliament and Council 2002), also named 'General Food Law' (GFL).

The GFL is considered the current pilaster of the whole EU food policy (Pisanello 2014a, b). According to this regulation, each player of the food chain—named 'food business operator' (FBO)—is completely responsible for the safety

and the legality of foods in compliance with food-oriented specific legislations. With exclusive relation to EU norms, one of the most important documents is the Regulation (EC) No 882/2004 on official controls for feed and food product (Pisanello 2014a). It has to be highlighted that the food chain is entirely considered, 'from farm to fork' (European Commission 2009): as a result, all steps—production, delivery, final distribution, etc.—are examined and monitored; differences between foods for human consumption and feed products for food-producing animals are not relevant with concern to the GFL. In addition, six points are clearly highlighted (Pisanello 2014a):

- Safety management
- Protection of consumers' interests
- Fair practices
- Protection of animal health and welfare (if appropriate)
- Plant health
- Attention to the environment
- Importance of risk analysis
- Guaranteed transparency (this point is correlated with the protection of consumers' interests).

These pilasters of the GFL could not be fully guaranteed in absence of dedicated instruments and a reliable organisation at the European level. In fact, many efforts have been recognised in the last decades to National governments (Knowles et al. 2007), but the lack of coordination had to be observed and some corrective/preventive measures had to be decided and rapidly implemented on a higher level. On the other side, FBO have been considered responsible for the definition and the practical application of general safety requirements; other requests concern a reliable traceability system and dedicated crisis management structures. Naturally, these efforts require a strong coordination at the legal level and the availability of scientifically sound opinions. For these reasons, the creation of the independent European Food Safety Authority (EFSA) has been decided with the introduction of GFL (European Parliament and Council 2002).

With reference to coordination and the exchange of information across the EU, a powerful and online system for the rapid communication of food- and feed-alerts and countermeasures had really been necessary. This exigency has been solved with the European Rapid Alert System for Food and Feed (RASFF). Basically, the RASFF is necessary when speaking of EFSA's responsibilities: the authority collects scientific data by different sources, and the RASFF is included (European Parliament and Council 2002; Jezsó 2015).

Actually, this system—very useful for the rapid exchange of information on food- or feed-related risks and the communication of countermeasures (Pisanello 2014a)—may be considered similar to the Rapid Alert System for Non-Food Consumer Products (RAPEX) system (Alemanno 2009, 2010; Ene 2011; Lundov and Zachariae 2008). Substantially, the RAPEX system concerns dangerous products (food, feed, pharmaceuticals and medical devices are excluded) and the

rapid exchange of alert notifications between Member States and the EU, with the possible involvement of non-EU countries. The similarity between RAPEX and RASFF is particularly evident when considering obligations of Member States in accordance with GFL, Article 50: National Authorities must communicate with the European Commission if possible non-compliances are revealed and concern health risks (or rejected food products at EU borders). This communication has to be extremely rapid and the RASFF is specifically mentioned (Jezsó 2015). Specific emergency measures can be immediately taken based on RASFF notifications: this situation has been observed several times with concern to imported foods and alert notifications for aflatoxins, GMO, dioxins, melamine, *Salmonella* contamination, etc. (Jezsó 2015).

RAPEX and RASFF have been created with the aim of providing rapid exchange information between EU Member States with relation to national controls. In particular, the RASFF has been created in 1979 as a cooperation system with the support of the following Member Countries: Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, the Netherlands and the United Kingdom (Bánáti and Klaus 2010; European Commission 2009; Jaud et al. 2013; Leuschner et al. 2013; Paganizza 2013). The subsequent EU Country was Greece (1981); Spain and Portugal joined the RASFF in 1986. At present, the system has the following active members, including non-EU Countries (European Commission 2009), with the year of membership into brackets:

- The European Commission, represented by the Health and Consumer Protection Directorate-General and the EFSA
- The European Free Trade Association (EFTA). EFTA includes Iceland, Liechtenstein, Norway and Switzerland
- Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, the Netherlands and the United Kingdom (1979)
- Greece (1981)
- Portugal and Spain (1986)
- Iceland, Liechtenstein and Norway (1994)
- Austria, Finland and Sweden (1995)
- Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia (2004)
- Bulgaria and Romania (2007)
- Switzerland (2009)
- Croatia (2013).

This list may be modified in future because of new entries in the EU. Five non-EU member Countries are classified as 'Candidate countries' and two Nations are considered 'Potential candidates' for EU membership in 2016 (EU 2016).

In brief, the RASFF is used with the aim of making easier the rapid communication between RASFF member Countries—notifying members—and the European Commission when potential information concerning serious health risks related to foods or feeds are available (European Commission 2009; Jezsó 2015). In

particular, notifications concern measures for the protection of consumers' health and temporal limits: withdraw and recall procedures are notified when speaking of foods and feed products on the market and the decided measure is taken with the aim of managing possible health risks (European Commission 2009). The rapid action is an important element of the notification. In accordance with the Commission Regulation (EU) No 16/2011 of 10 January (European Commission 2011) and the RASFF User Manual,[1] the RASFF can give the following notification details (Paganizza 2013):

- Reference number:
- Notification date:
- Last update:
- Notification type:
- Action taken (compulsory actions or voluntary measures). The role of the FBO is also mentioned
- Origin of the notification
- Information about the distribution of the food or feed on the EU market at the date of the original notification
- Product category:
- Information with relation to unacceptable risks
- Information with relation to the receiving country or countries
- Origin of the product (different from the origin of notification).

Basically, notifications may be subdivided (Fig. 1.1) into three main categories, named 'original notifications', and two non-original notifications, depending on the associated hazard (European Commission 2009, 2011; Paganizza 2013):

(1) Original notifications: alert notifications, border rejection notifications and information notifications
(2) Non-original notifications: follow-up notifications; other information, also named 'news'.

The 'alert notification' concerns all safety risks correlated with the presence of a peculiar food or feed on the EU market and the immediate required action. The above-mentioned examples—withdraw and recall procedures—are specifically considered: the RASFF member which has (a) identified the risk and (b) decided the required action, has to communicate immediately the situation and all known information to the whole RASFF network. Consequently, the alert situation is rapidly diffused across the whole 'RASFF area' and all RASFF member Countries are able to take needed procedures and actions in their national areas and markets (European Commission 2009).

A different situation can be observed when speaking of 'border rejection' notifications. The original cause is always the detection of a possible safety risk

[1]This document, accessed 04 March 2016, is available at the following link: https://webgate.ec.europa.eu/rasff-window/help/Help%20file%20for%20RASFF%20Portal.pdf.

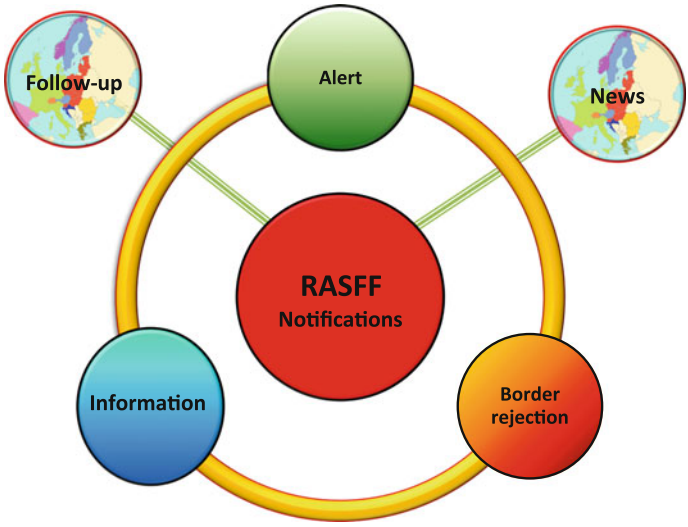

Fig. 1.1 RASFF notifications may be subdivided into three main categories, named 'original notifications' and two non-original notifications. Original notifications concern: alerts border rejection episodes and information 'for follow-up' and 'for attention'. Non-original notifications are follow-up notifications (additional information in relation to a pre-existing original notification) and 'news' (interesting food or feed safety information for the whole RASFF network: however, the importance of the above-mentioned notes does not require the 'alert', 'border rejection' or 'information' classification)

correlated to foods and feeds, and the difference with 'alert notifications' appears mainly correlated to the geographical detection of risks: the external border of the EU and the broader 'European Economic Area' (EEA). In other words, possibly hazardous foods and feeds are not allowed to enter the RASFF area because of preventive controls at borders. Figure 1.2 shows the geographical extension of RASFF member countries and the related year of membership. Substantially, should any possible food or feed product be examined and found 'non-compliant' (with mandatory EU or national norms at least) with the consequent rejection, a related notification would be immediately made to all EEA Countries with the aim of reinforcing border controls. The basic objective is the necessity of blocking undesired food and feed products at borders after the detection of possible safety risks: naturally, the rapidity of RASFF communications is crucial (European Commission 2009).

The third RASFF category—'information notifications'—is correlated with the importance of food or feed safety risks. In other words, a simple information notification concerns only possible hazards without the necessity of taking immediate actions (European Commission 2009). As a result, RASFF members are not obliged to consider rapid actions; reasons may be different. These information can be classified as follows:

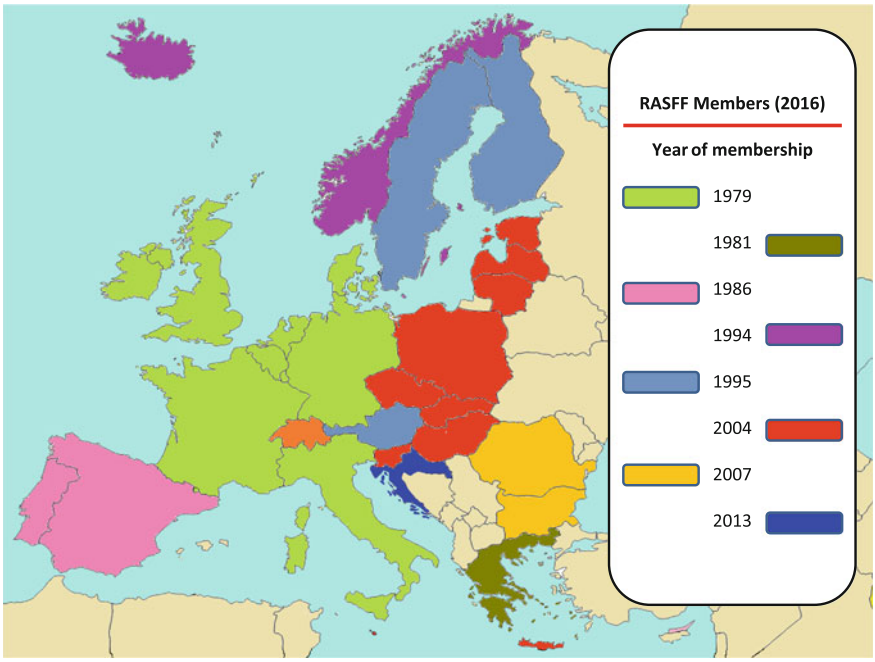

Fig. 1.2 The geographical extension of RASFF member countries in 2016 and the related year of membership. The following countries are shown here: Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, the Netherlands and the United Kingdom (year of membership: 1979); Greece (1981); Portugal and Spain (1986); Iceland, Liechtenstein and Norway (1994); Austria, Finland and Sweden (1995); Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia (2004); Bulgaria and Romania (2007); Switzerland (2009); and the last member, Croatia (2013)

The 'information notification for follow-up' concerns detailed information—by a member Country—with reference to a food or feed product which can be found or will be found on the market of another member Country.

On the other side, the 'information notification for attention' concerns the following situations:

- The food or feed product would not reach a peculiar RASFF member country
- The food or feed is no longer present on the market of interested RASFF members
- The nature of the food or feed safety risk may require management actions without the necessity of immediate measures.

Follow-up notifications are different from 'alert', 'information' and 'border rejection' notifications (also grouped as 'original notifications): these documents contain additional information in relation to a preexisting original notification (European Commission 2011). Good examples can concern information on food safety, hazards and traceability (PIP 2016).

Finally, remaining notifications—also named 'news'—concern interesting food or feed safety information for the whole RASFF network: however, the importance of the above-mentioned notes does not require the 'alert', 'border rejection' or 'information' classification. Transmitted documents may be useful when speaking of consumers' protection and official controls (European Commission 2009, 2011; PIP 2016); as a result, RASFF member countries are free to take note of 'news' notifications.

Two new instruments have been recently introduced (Paganizza 2013):

(a) The online real-time notification 'Interactive rapid alert system for food and feed' (iRASFF)
(b) The RASFF Consumer Portal.

The so-called iRASFF system, has been initially supported by a small group of RASFF members (Paganizza 2013); at present, it is completely active (European Commission—Health and Food Safety 2015). Substantially, the new electronic platform allows each notifying RASFF member country to communicate directly all interested notification data by means of the direct insertion in the system, while the previous procedure considers only the preventive communication via e-mail messages. All information are carefully checked by a National Contact Point (European Commission 2013); after this check, notifications can be sent to the whole RASFF network. In addition, every RASFF member can subsequently insert new details after the first notification issue.

The RASFF Consumer Portal, inaugurated for the RASFF's 35th anniversary (European Commission—Health and Food Safety 2015), could be seen as a simplified vision of the whole RASFF: summary information of different RASFF notifications can be obtained by means of this portal. However, it has to be noted that only a selection of all notifications are displayed by the online system.[2] In addition, notifications are supplied by countries (European Commission—Health and Food Safety 2015). The portal concerns RASFF notifications with a peculiar action: consumers' recalls. Moreover, all notifications with some given information by one or more Member Countries or FBO are considered in the selection. In addition, selected notifications concern the past 4 weeks only. Should information be available, the portal would also display them in a dedicated 'More info' column. Alternatively, information would be requested to one of the national consumer recall or given information web, according to the 'RASFF consumers portal—introduction' document.[3] After 4 weeks, these notifications are removed.

On these bases, the rapid communication of food safety risk information has been progressively accelerated in the last decades. The original idea of the RASFF (1979) was conceived after the detection of mercury into contaminated oranges in the Netherlands and in West Germany (origin: Israel). The intentional act (political

[2]Web site: https://webgate.ec.europa.eu/rasff-window/consumers/.

[3]This document, accessed 04 March 2016, is available at the following link: https://webgate.ec.europa.eu/rasff-window/help/RASFF%20consumers%20portal%20introduction.pdf.

terrorism), very similar to the currently discussed problem of adulteration, damaged heavily the commerce of these products in West Germany (European Commission 2009). Actually, the first RASFF agreement was defined as a 'Gentlemen's agreement' between some Members of the old European Economic Community. Consequently, the RASFF network was not complex if compared with the current structure and only serious and immediate risks were considered. In addition, the first notifications were not written: the first of these information concerned spoiled calamari (1979). Before 1995, other well-known food safety situations concerned the following episodes (European Commission 2009):

(a) *Clostridium botulinum* type E in contaminated white bean curd with chilli (origin: Hong Kong; year: 1981)
(b) Diethylene glycol in white wines (origin: Austria; year: 1985)
(c) Methanol in wines (origin: Italy; year: 1986)
(d) Radioactivity in crops (origin: Soviet Union, Eastern Europe; year: 1986).

After the creation of the EU internal market (1992), other countries joined the RASFF: Iceland, Norway and Liechtenstein in 1994 (they are part of the EEA only) and Austria, Finland and Sweden one year later. Substantially, many different menaces were recorded after 1992: the so-called 'mad cow disease' in 1995 (no consequences for human consumers); the detection of aflatoxins in imported pistachios (1998) and dioxins in contaminated feed for chicken (1999). Other safety and adulteration episodes have been recorded until now and the emerging problem of authenticity demonstrates the current importance of RASFF notifications. Subsequently, the role of the notification system has been also empowered with the Regulation (EC) N° 178/2002 and the so-called 'Hygiene Package' (European Commission 2009). As a result, the number of notifications has grown up after 2002; at present, this number is approximately 7000 per year (until 2008).

At present, the RASFF system is implemented in accordance with the Commission Regulation (EU) No 16/2011 (Capelli 2011); however, the main framework document remains the Regulation (EC) N° 178/2002 (PIP 2016). In addition, the role of the Regulation (EC) No 882/2004 has to be highlighted when speaking of official controls on food and feed products (European Parliament and Council 2004).

The current situation of RASFF notifications may be analysed with interesting results and compared with 'historical' results. The aim of subsequent chapters is the statistical examination of available data in the last years from a chemical viewpoint, although other food safety risks have to be briefly considered.

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Chapter 2
RASFF Alert and Information Notifications. A Statistical Review

Abstract This chapter contains a statistical evaluation of RASFF alert notifications in general. The study concerns the comparison between recorded alerts in two different temporal periods, the broad 1979–1990 and the four-year 2011–2014 intervals. The analysis of product categories and hazard categories has been performed with the aim of defining the next 'emerging concerns' by the food safety viewpoint. Moreover, authors have analysed all calculated results with relation to a new risk classification (seven different risk typologies, including adulteration, and fraud episodes, processing failures, allergens, and GMO). In addition, the chapter discusses chemical risks and contaminants, including also allergens.

Keyword Adulteration · Alert notification · Allergens · Chemical contamination · General sensorial failures · GMO · HACCP · Hazard category · Processing failures · RASFF

2.1 The RASFF and the Analysis of Notifications. An Overview

The Rapid Alert System for Food and Feed (RASFF) has been created in the European Union with the aim of providing rapid exchange information between European Union (EU) Member States with relation to national controls on food and feed products (Bánáti and Klaus 2010; European Commission 2009; Jaud et al. 2013; Paganizza 2013). In general, the RASFF can make easier the rapid communication between RASFF member Countries—notifying members—and the European Commission when potential information concerning serious health risks related to foods or feeds are available (Sect. 1.1; Jezsó 2015). Because of the critical importance of rapid communications, all information—also named 'notifications'—concern the detail of food or feed-related risks and correlated measures

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for the protection of consumers' health, with temporal limits. The most important examples are surely withdraw and recall actions when speaking of foods and feed products on the market (Sect. 1.1; European Commission 2009).

In accordance with the Commission Regulation (EU) No 16/2011 of 10 January (European Commission 2011), the RASFF can give the following notification details:

- Reference number
- Notification date
- Last update
- Notification type
- Action taken. The role of the Food Business Operator (FBO) is also mentioned
- Origin of the notification
- Information about the distribution of the food or feed on the EU market at the date of the original notification
- Product category
- Information with relation to unacceptable risks
- Information with relation to the receiving Country or Countries
- Origin of the product (different from the origin of notification).

In addition, the nature of different notifications should be explained. Notifications may be subdivided (Sect. 1.2) in three main categories, named 'original notifications', and two non-original notifications, depending on the associated hazard:

(1) Original notifications: alert notifications, border rejection notifications, and information notifications.
(2) Non-original notifications: follow-up notifications; other information, also named 'news'.

Actually, original notifications can be easily used with the aim of defining a useful food safety approach against old and new (emerging) risks. This concept is intrinsically linked with the Hazard Analysis and Critical Control Points (HACCP) approach in food industries (Gurnari 2015; Unnevehr and Jensen 1999). The calculation of shelf life and the practical management of certain processing indicators during production are useful; the development of statistical tools and software products is also interesting when speaking of the analysis of risks in a proactive and predictive manner (Parisi 2002; Parisi et al. 2004, 2016a, b). Moreover, most known quality management standard are based on this idea (Stilo et al. 2008).

At present, RASFF notifications are studied from the statistical viewpoint and results are provided by the European Commission's RASFF team (European Commission—Health and Food Safety 2015) by means of an annual report. With the exclusion of 2015 and 2016 years, elaborated data cover the whole 2002–2014 period; in addition, some data are available with relation to the whole number of notifications since 1999 (698 notifications) to 2014 (European Commission 2009).

On these bases, the RASFF can be a useful tool for the preventive evaluation of old and emerging food safety risks in the EU. In other words, the tendency of food-related risks may be investigated by means of RASFF data. Several authors have already made interesting studies with relation to restricted temporal periods (Hruska and Franek 2009; Jaud et al. 2013; Zhang et al. 2012). These researches have demonstrated that the definition of dedicated indicators could be useful when speaking of emerging issues and predictive approaches (Kleter et al. 2009). Moreover, examined data from EU food monitoring may be combined with other data concerning different aspects of the food and beverage sector: good examples could be production costs and economic indicators (Palou 2005).

Anyway, the analysis of RASFF data is not simple because each notification may be classified in five different ways. Moreover, RASFF hazards are a broad group of terms. Roughly, these factors could be classified as:

(a) Chemical substances
(b) Microbiological agents
(c) Various parasites
(d) Food packaging concerns, including hygienic failures
(e) General food and hygiene concerns
(f) Quality failures
(g) Food adulterations
(h) Nutritional labeling concerns.

On the other hand, this is only a provisional list because of the apparently uninterrupted evolution of the whole food and beverage sector. This trend cannot be stopped because the field is inextricably connected with non-food activities and disciplines such as general microbiology, chemical processes and engineering, economics, regulatory norms, etc. Consequently, the analysis of RASFF notifications and related causes can be used only with the aim of tracing a hopefully good prediction of future food concerns.

This chapter aims to give a reliable estimation of current and past tendencies in the field of food safety. Because of the high frequency of border rejection notifications and situations with ‘undecided’ or ‘not serious’ risk decisions (information for attention and follow-up), Authors have decided to subdivide the analytical research in two different chapters with relation to serious risks and the block of food and feed commodities at EU borders. For these reasons, Chap. 3 is dedicated to border rejection notifications. The following Sections of Chap. 2 discuss:

(a) The analysis of most recurrent food safety concerns with rapid required actions (alert notifications) and related ‘product categories’ in the following periods: 1979–1990 (11 years) and 2011–2014 (four years)
(b) The analysis of most recurrent food safety concerns with rapid required actions (alert notifications) and related ‘hazard categories’ in the following periods: 1979–1990 (11 years) and 2011–2014 (four years)
(c) The discussion of observed differences between the above-mentioned temporal periods

(d) The study of observed concerns by a more specific HACCP viewpoint with the addition of adulteration episodes and other food safety concerns
(e) A brief comparison between obtained results and trends on the one hand, and the most recent overview of hazard categories with reference to information notifications (year 2014) on the other side.

Statistical elaborations have been made on the basis of RASFF original data. In general, the RASFF Portal[1] can be used to obtain interesting data on a condition that several inputs are given. With reference to our study, the following parameters have been used for research purposes:

(a) Classification of notifications (alert)
(b) Hazard category (variable)
(c) Date of notification (interval between two temporal dates)
(d) Product category.

2.2 RASFF Alert Notifications. Food Safety Concerns and Related 'Agents' (1979–1990)

The initial years of RASFF notifications have considered exclusively alert notifications by member countries until 1989. For this reason, authors have decided to study the situation of most common food safety alerts by a RASFF viewpoint in the broad 1979–1990 period (11 years).

The first part of statistical evaluations has concerned the composition of food safety notifications (alerts only) with relation to the product category (Figs. 2.1 and 2.2). In detail, it should be noted that the current classification of products is based on three definitions: food, feed, and food contact materials (European Commission—Health and Food Safety 2015). However, one single alert notification has been found in the RASFF between 1979 and 1990 with relation to the detection of lead in animal feeding stuffs (product category: animal nutrition, obsolete; date: 10/11/1989, reference: 1989.24). As a consequence, the total number of alert notifications in this period (201 references) is mainly ascribed to food products and food packaging materials. Figure 2.1 shows the subdivision of notifications with relation to 12 categories (alcoholic beverages—fruits and vegetables), while Fig. 2.2 gives the overview of notifications for the remaining 12 products (herbs and spices—wine).

In general, the largest part of alert notifications—78.2 %—with associated high food safety concerns are ascribed to the following categories of products (related percentage values are mentioned in brackets):

[1]The RASFF Portal can be accessed at the following link: https://webgate.ec.europa.eu/rasff-window/portal/?event=SearchForm&cleanSearch=1.

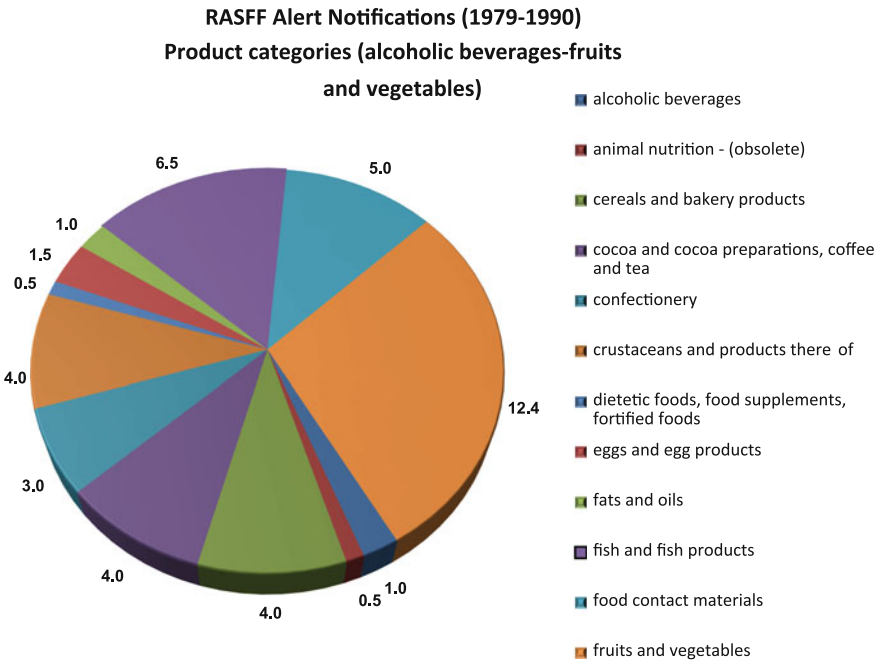

Fig. 2.1 The RASFF and food safety. Statistical evaluation of food safety alerts in the 1979–1990 temporal period (11 years). The subdivision of notifications concerns 12 products categories (from 'alcoholic beverages' to 'fruits and vegetables'). The remaining 12 product categories are shown in Fig. 2.2

(1) Molluscs and products thereof (obsolete category, 15.9 %)
(2) Meat and meat products (other than poultry: 12.9 %)
(3) Fruit and vegetables (12.4 %)
(4) Milk and milk products (8.5 %)
(5) Fish and fish products (6.5 %)
(6) Food contact materials (5.0 %)
(7) Wine (5.0 %)
(8) Cereals and bakery products (4.0 %)
(9) Cocoa and cocoa preparations, coffee and tea (4.0 %)
(10) Crustaceans and products thereof (4.0 %).

Substantially, the main part of food safety concerns in the 1979–1990 period appear mainly linked with foods of animal origin (total percentage value: 47.8 %), while vegetable foods are relevant enough (25.4 %) with the most important category of 'fruits and vegetables' (12.9 %). Food contact materials appear to have a low importance (5.0 %); however, the presence of these notifications in the first years of the RASFF system should be noted. It could be also highlighted that certain transformed products—confectionery; 'dietetic foods, food supplements,

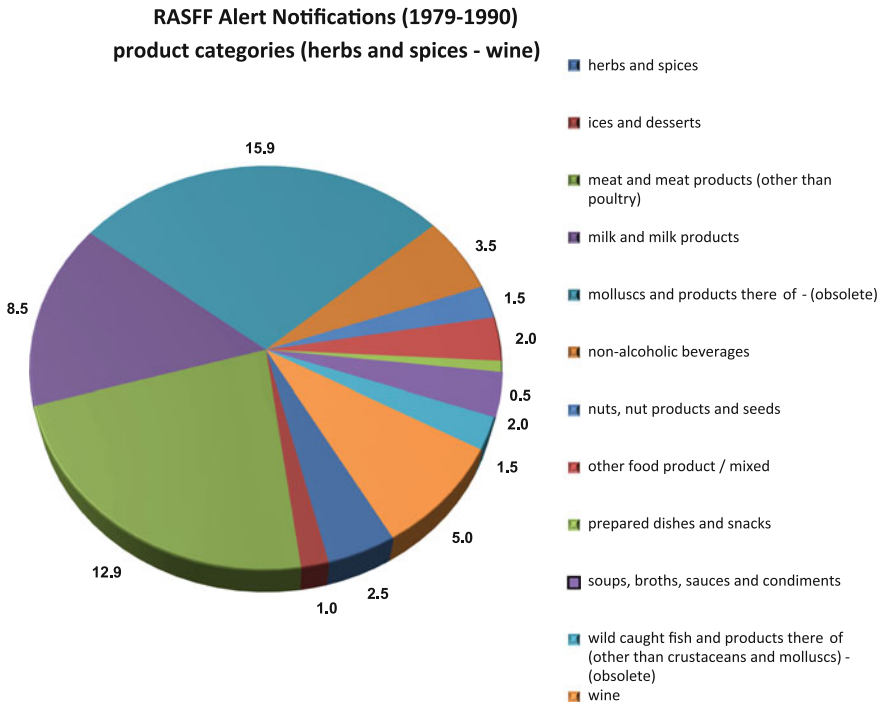

Fig. 2.2 The RASFF and food safety. Statistical evaluation of food safety alerts in the 1979–1990 temporal period (11 years). The subdivision of notifications concerns 12 products categories (from: 'herbs and spices' to 'wine'). The remaining 12 product categories are shown in Fig. 2.1

fortified foods'; herbs and spices; prepared dishes and snacks—are not mentioned with notable frequency. Actually, the current situation is not similar (Sect. 2.4).

The second part of the study concerns the analytical evaluation of alert notifications with reference to hazard categories, as currently defined by the RASFF system (European Commission 2010; Kleter et al. 2009; Leuschner et al. 2013; Tedesco et al. 2008; Wiig and Kolstad 2005). Figure 2.3 shows the situation in the 1979–1990 period. The most important alerts are ascribed mainly to pathogenic microorganisms (20.7 %), biotoxins (19.7 %) and non-pathogenic microorganisms (9.1 %). It has to be clarified that the term 'biotoxins' concerns mainly marine toxins such as shellfish biotoxins (Delia et al. 2015; Motarjemi and Lelieveld 2013). As a result, it may be inferred that 49.5 % of the total number of alert notifications in the initial years of the RASFF system have concerned the microbiological risk in the HACCP ambit. This result may be considered also as the measure of the psychological impact of food scares in the above mentioned period: microbial contamination episodes have been discussed broadly in the scientific literature since 1970s (Gordon 1973). On the other hand, the 'chemical risk' appears relevant enough (22.8 %) if four hazard categories are considered together (related percentage values are expressed in brackets):

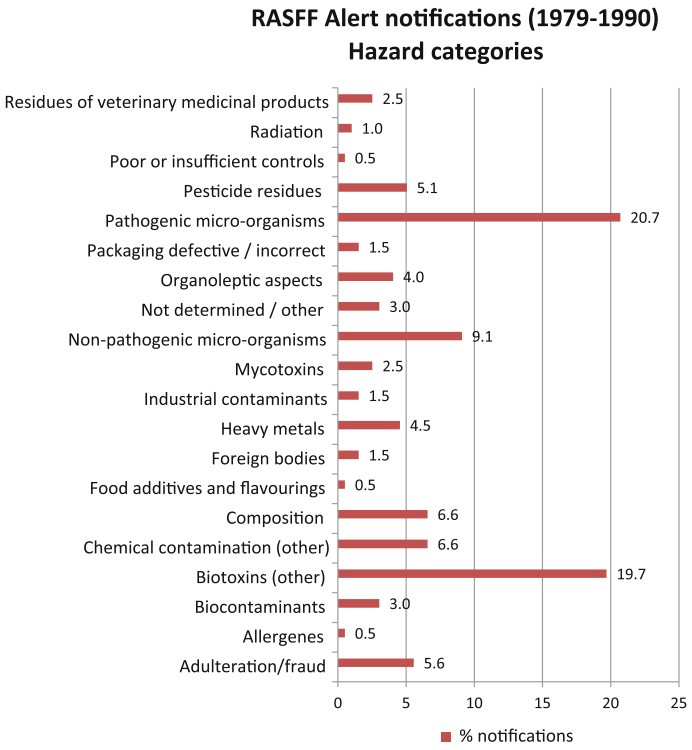

Fig. 2.3 The analytical evaluation of RASFF alert notifications with reference to hazard categories in the 1979–1990 period

- Chemical contamination. This category concerns all possible contamination episodes without detection of pesticides, heavy metals and other mentioned contaminants in remaining hazard categories (6.6 %)
- Composition (6.6 %)
- Pesticide residues (5.1 %)
- Heavy metals (4.5 %).

It should be also noted (Fig. 2.3) that:

(a) General sensorial alterations and non-determined food safety problems can reach an interesting 7.0 % value when considered together
(b) Notifications concerning foreign bodies account for only 1.5 % of the total number of alert notifications
(c) Adulteration and fraud situations 'weights' 5.6 % if compared with the total number of alert notifications. This result can be interesting enough because the historical period cannot contemplate 'global' food scandals such as the problem of horsemeats (Bánáti 2014; O'Mahony 2013; Premanandh 2013).

With reference to the 1979–1990 temporal interval, there are 20 notified hazard categories (according to the modern RASFF system):

- Adulteration/fraud
- Allergens
- Biocontaminants
- Biotoxins (other)
- Chemical contamination (other)
- Composition
- Food additives and flavourings
- Foreign bodies
- Heavy metals
- Industrial contaminants
- Mycotoxins
- Non-pathogenic micro-organisms
- Not determined/other
- Organoleptic aspects
- Packaging defective/incorrect
- Pathogenic microorganisms
- Pesticide residues
- Poor or insufficient controls
- Radiation
- Residues of veterinary medicinal products.

The above mentioned list corresponds to the RASFF vision of food- and feed-related hazards. However, HACCP managers could find some difficulties when analysing the whole database for clarification purposes 'as it is'. For this reason, the list of hazard categories could be modified with the aim of providing interested users a sort of HACCP vision of the 'alert' level in the RASFF area.

In other words, the statistical evaluation of most important and recurring alert notifications could be made with the 'translation' of the list of RASFF hazard categories in the following list of 'HACCP risks and other food safety concerns':

- Microbiological risks
- Chemical risks
- Foreign bodies
- Adulteration and fraud episodes
- General sensorial failures
- Other food safety concerns: processing failures
- Other food safety concerns: allergens, genetically modified organisms (GMO) and novel foods.

The new classification of HACCP risks and other concerns should be explained.

For clarification purposes, 'microbiological risks' concern the following hazard categories:

(1) Transmissible spongiform encephalopathy (TSE), also known as the 'mad cow disease' (Caughey and Chesebro 1997; Jeffrey and Gonzalez 2004)
(2) Biocontaminants
(3) Biotoxins (other)
(4) Mycotoxins
(5) Non-pathogenic micro-organisms
(6) Parasitic infestation
(7) Pathogenic microorganisms.

Secondly, 'chemical risks' comprehend the following categories:

- Chemical contamination (other)
- Composition
- Feed additives
- Food additives and flavourings
- Heavy metals
- Industrial contaminants
- Pesticide residues
- Radiation
- Residues of veterinary medicinal products.

'Foreign bodies' and 'adulteration and fraud episodes' coincide with the above mentioned hazard categories of the same name.

Subsequently, 'general sensorial failures' concern 'not determined/other' notifications and organoleptic aspects. The group of 'processing failures' means the following categories:

- Absent, incomplete, or incorrect labeling
- Migration
- Packaging defective/incorrect
- Poor or insufficient controls.

These risks and concerns are correlated to processing failures, packaging defects, quality control activities and labeling problems.

It should also be clarified that the general HACCP approach concerns microbiological risks, chemical hazards, and the detection of foreign bodies. However, the new classification takes into count the 'new entry' of authenticity concerns (adulteration and fraud episodes). Moreover, sensorial defects and unclear situation would need a separated classification; the same thing can be affirmed when speaking of allergens and GMO on the one hand (possibility of psychological adverse reactions in consumers; allergic reactions) and all possible non-food related failures with one or more process relationship (Baker and Burnham 2001; Hubbard 2012). However, the new approach should be comprehensible for HACCP managers and professional auditors facing sectoral concepts in a more simplified manner.

The new classification of 'HACCP risks and other food safety concerns' can be useful because of the possible interpretation of alert notifications on the basis of the

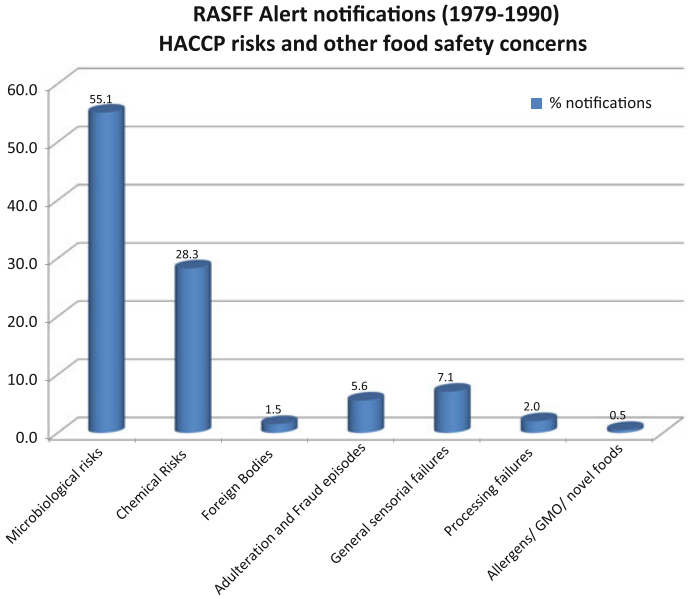

Fig. 2.4 The analytical evaluation of RASFF alert notifications (1979–1990) with reference to a new classification: 'HACCP risks and other food safety concerns'. The proposed classification concerns: microbiological risks, chemical risks, foreign bodies, adulteration and fraud episodes, general sensorial failures, other food safety concerns: processing failures, other food safety concerns: allergens, GMO and novel foods

hazard analysis and critical control approach. Substantially, HACCP (and quality) managers working in food companies and other players of the whole food and feed chain would need to analyse the trend of food hygiene and public safety menaces during long periods. The aim is naturally the reliable prediction of new and emerging failures; in addition, each forecast concerning a new or recurring (cyclic) food safety concern may be very useful when speaking of the general trend of raw materials and certain finished products in the (globalised) market (Connor 1994; Cotterill 1986; Falguera et al. 2012).

Consequently, authors have re-elaborated RASFF alert notifications between 1979 and 1990: Fig. 2.4 shows the new situation.

Once more, the 'microbiological risk' group appears the most recurring menace: 55.1 % of the total number of alert notifications is linked with microbiological food scares. As a result, it can be confirmed that the first level-food menace between 1970s and 1990s was perceived in strict connection with microbiological 'agents'.

Chemical risks account for 28.3 % of the total amount of alert notifications (Fig. 2.4). Actually, chemical 'menaces' are extremely variegated; however, it can be noted that official authorities had already considered the world of food products as an interconnected sector (foods/packages/chemicals/other services) in the last decades.

General sensorial failures and unclear situations have generated 7.1 % of the total number of RASFF alerts (Fig. 2.4): this result corresponds to an approximate 12.9 % value if compared with microbiological failures only. On the other hand, many sensorial defects appear caused by microbial spreading: should this hypothesis be assumed, the total number of alert notifications in the RASFF area by microbiological 'agents' could rise to 62.2 %. Interestingly, adulteration and fraud episodes reach 5.6 %, while GMO and allergens (Barbieri et al. 2014) do not seem serious menaces between 1979 and 1990. Processing failures are only 2.0 %. Finally, the detection of foreign bodies has been highlighted 1.5 times on 100 RASFF alert notifications; from the safety viewpoint, it could be affirmed that the 'physical risk' (Corlett and Pierson 1992; Corlett and Stier 1991; Hoornstra et al. 2001) had been managed well in the last decades.

After this overview of RASFF results in the initial years, an interesting comparison may be performed with analogous calculated data between 2011 and 2014.

2.3 Recent RASFF Alert Notifications. Food Safety Concerns and Related 'Agents' (2011–2014)

After many years, the RASFF has been significantly grown and modified: as a simple example, the continuous evolution of notifications (from the simple 'alert' to the issue of 'information' documents and border rejections and the final subdivision of information notifications) have generated a more complex framework of the entire food safety in the RASFF area. Because of the necessity of analysing a notable complexity of data (Potter et al. 2012), authors have decided to study the situation of most common food safety alerts by a RASFF viewpoint after the first 'mad cow' episodes, between 2011 and 2014 (Pennings et al. 2002).

The first part of statistical evaluations has concerned the composition of food safety notifications (alerts only) with relation to the product category (Figs. 2.5, 2.6 and 2.7). Once more, the current classification of products is based on three definitions: food, feed and food contact materials (Sect. 2.2). In Difference to the early years of the notification system, the RASFF portal reports the subdivision of total alerts (2449 documents) in the following way:

(1) Food-related notifications: 2,187
(2) Feed-related notifications: 115
(3) Food-contact materials-related notifications: 147.

In other terms, 89.3 % of the total alert notifications are ascribed to the type category: food; on the other side, 10.7 % concern feeds and food-contact materials. These results demonstrate that a certain attention to food packaging materials and feeds is expected.

Figure 2.5 shows the subdivision of notifications in relation to 12 categories (alcoholic beverages—feed additives), while Figs. 2.6 and 2.7 give the overview of notifications for the remaining products.

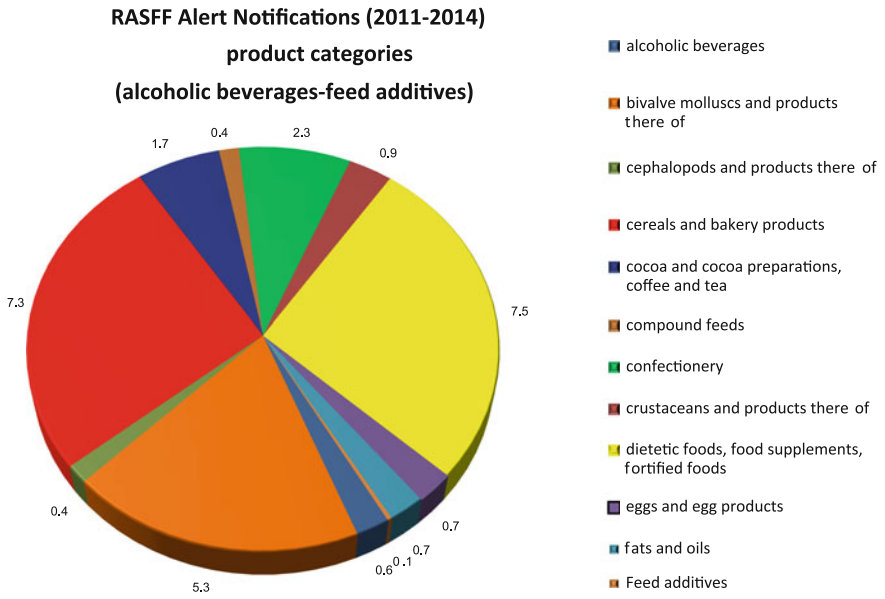

Fig. 2.5 The RASFF and food safety. Statistical evaluation of food safety alerts viewpoint in the 2011–2014 temporal period (four years). The subdivision of notifications concerns 12 products categories (from: 'alcoholic beverages' to 'feed additives'). The remaining product categories are shown in Figs. 2.6 and 2.7

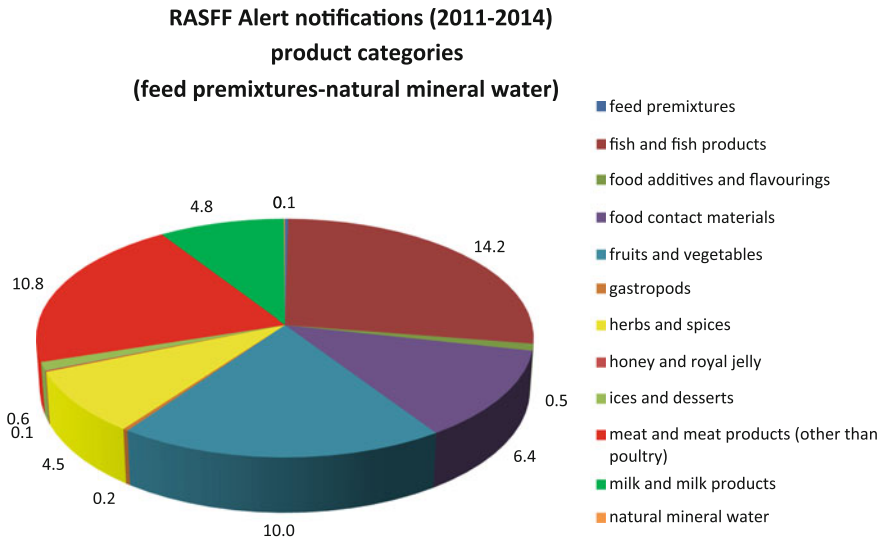

Fig. 2.6 The RASFF and food safety. Statistical evaluation of food safety alerts viewpoint in the 2011–2014 temporal period (four years). The subdivision of notifications concerns 12 products categories (from: 'feed premixtures' to 'natural mineral water'). The remaining product categories are shown in Figs. 2.5 and 2.7

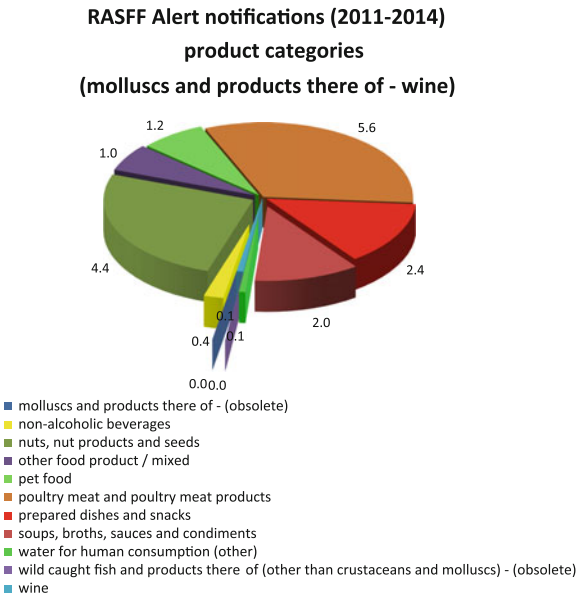

Fig. 2.7 The RASFF and food safety. Statistical evaluation of food safety alerts viewpoint in the 2011–2014 temporal period (four years). The subdivision of notifications concerns 11 products categories: from: 'molluscs and products thereof—(obsolete)' to 'wine'). The remaining product categories are shown in Figs. 2.5 and 2.6

In general, the major part of alert notifications—78.2 %—with associated high food safety concerns are ascribed to the following product categories (related percentage values are mentioned in brackets):

(1) Fish and fish products (14.2 %)
(2) Meat and meat products (other than poultry, 10.8 %)
(3) Fruits and vegetables (10.0 %)
(4) Dietetic foods, food supplements, fortified foods (7.5 %)
(5) Cereals and bakery products (7.3 %)
(6) Food contact materials (6.4 %)
(7) Poultry meat and poultry meat products (5.6 %)
(8) Bivalve molluscs and products thereof (5.3 %)
(9) Nuts, nut products, and seeds (4.4 %).

The comparison between 1979–90 and 2011–14 results has demonstrated that:

(a) Alerts concerning fish and fish products have been notified with a substantial augment: +7.7 %; as a result, high concerns related to fish products are now the first cause of alert in the RASFF area. It can be inferred that these foods are undoubtedly 'under pressure'
(b) Alert notifications related to meat and meat products are slightly diminished if compared to early years (variation: −2.1 %). On the other hand, this product category is surely under strict control at present (2nd place)
(c) Fruit and vegetables show a little decrease (−2.4 %). The third place in the special list of products categories implies that the surveillance remains high

(d) Dietetic foods, food supplements and fortified foods show a remarkable amount of alert notifications between 2011 and 2014 (7.5 %); the same category had 0.5 % of total alert notifications between 1979 and 1990. A possible explanation could be correlated with the notable increase of dietetic products in the last years
(e) Cereals and bakery products have reached the 5th place in the above mentioned list with +3.3 % in comparison with 1979–1990
(f) Food contact materials are often cited in RASFF alert notifications (6th place is unchanged), but the number of notifications is different; a −1.4 %—decrease has been calculated
(g) Poultry and similar products are ranked 7th in the 2011–2014 list
(h) Bivalve molluscs and products thereof hold the 8th place with 5.3 %. In contrast, the obsolete category of 'molluscs and products thereof' reached a notable 15.9 % in 1979–1990
(i) Milk and milk products have 'lost' many places in the 2011–2014 list of alert notifications: the amount of documents (4.8 %) is really lower than the previous number of alerts (8.5 %). It could be supposed that the safety surveillance on this food category has been really 'sharp'
(j) Finally, the comparison between the two lists shows the 'new entry' of nuts, nut products, and seeds (probably because of many concerns related to mycotoxins) and the reduced importance of wines (from 5.0 in 1979–1990 to 0.1 % in 2011–2014).

In general, there are not prevailing areas when speaking of product categories at present. In addition, the increase of dietetic products, food supplements and the remarkable importance of bakery products (and cereals) and transformed products (soups, prepared dishes. etc.) seem to have modified and fragmented the previous 'framework' of alert notifications. In other words, the statistical analysis of 2011–2014 alerts seems to show the current situation of food market shares.

The second part of the study concerns the analytical evaluation of alert notifications with reference to hazard categories, as currently defined by the RASFF system (Sect. 2.3). Figure 2.8 shows the situation in the 2011–2014 period. The most important alerts have been ascribed mainly to:

(1) Pathogenic microorganisms (30.3 %; previous value: 20.7 %)
(2) Heavy metals (11.8 %; previous value: 4.5 %)
(3) Allergens and mycotoxins (9.3 %; previous values: 0.5 and 2.5 % respectively).

With the exception of pathogen agents (1st place in 1979–1990 and 2011–2014; unchanged importance as food safety risk), the remaining top dangers in the first 11 years of RASFF alerts—biotoxins and non-pathogenic microorganisms have undoubtedly reached lower results: 2.6 instead of 19.7 % and 0.6 instead of 9.1 % respectively.

In general, it may be inferred that the psychological impact of food scares between 2011 and 2014 and the publication of new information about food safety have completely changed the framework of food safety concerns. In other words,

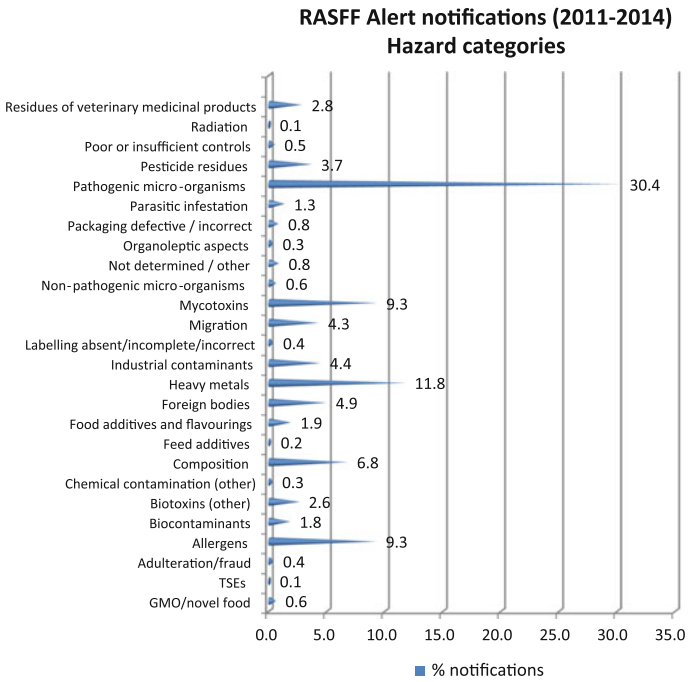

Fig. 2.8 The analytical evaluation of RASFF alert notifications with reference to hazard categories in the 2011–2014 period

the statistical evaluation of most important and recurring alert notifications could be made with the 'translation' of the list of RASFF hazard categories in the list of 'HACCP risks and other food safety concerns' (Sect. 2.2). This approach can be used with the aim of simplifying the study of 'risk profiles' according to the RASFF. Once more, the proposed list mentions:

- Microbiological risks
- Chemical risks
- Foreign bodies
- Adulteration and fraud episodes
- General sensorial failures
- Other food safety concerns: processing failures
- Other food safety concerns: allergens, genetically modified organisms (GMO) and novel foods.

On these bases, calculated data have been re-elaborated: Fig. 2.9 shows related results.

Once more, the 'microbiological risk' group appears the most recurring menace: 46.1 % of the total number of alert notifications is linked with microbiological food scares. However, this result was 55.1 % between 1979 and 1990. As a consequence, it may be assumed that the 1st level—food menace is perceived in strict

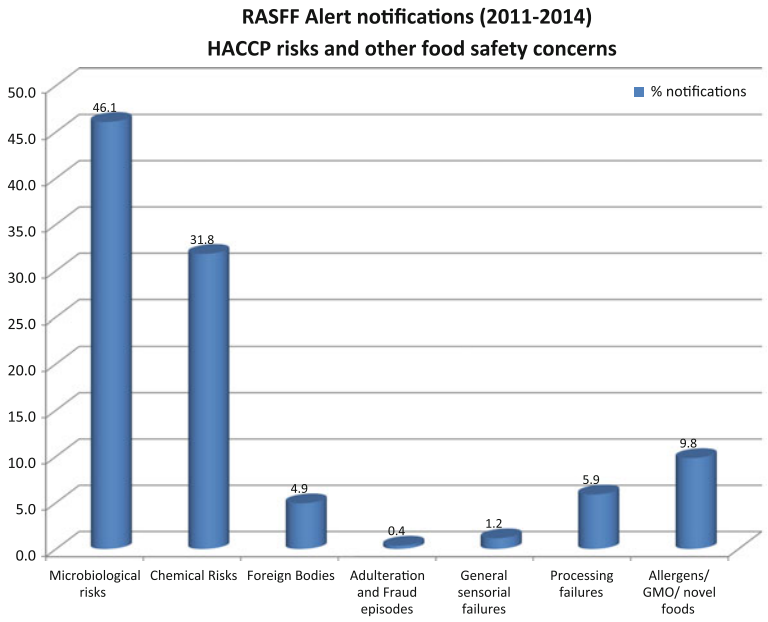

Fig. 2.9 The analytical evaluation of RASFF alert notifications (2011–2014) with reference to a new classification: 'HACCP risks and other food safety concerns'. The proposed classification concerns: microbiological risks, chemical risks, foreign bodies, adulteration and fraud episodes, general sensorial failures, other food safety concerns: processing failures, other food safety concerns: allergens, GMO and novel foods

connection with microbiological 'agents' at present with a significant −9.0 % if compared with previous results (Sect. 2.2, Fig. 2.4). On the other hand, alert notifications can be evaluated with relation to the average amount of notifications per year. It should be noted that:

(a) The average number of alert notifications per year between 1979 and 1990 (11 years) with microbiological 'causes' is approximately 5.0 %
(b) The average quantity of alerts per year in the 2011–2014 period with microbiological agents is 11.5 %.

Substantially, the first place is ascribed to microbiological-related alerts and the level of attention has significantly grown in the last years: alert notifications per year are more than doubled if compared with previous data.

Chemical risks account for 31.8 % of the total amount of alert notifications (Fig. 2.9) between 2011 and 2014. Apparently, the number is increased in comparison with 1979–1990 (28.0 %, estimated decrease: −3.8 %). However, average numbers per year demonstrate clearly that the perception of chemical risks is extremely higher at present: the 2011–2014 estimation per year is 8.0 % and the calculated result for 1979–1990 (11 years) is only 2.6 %. In other terms, the attention for chemical risks in the food and feed sector is extremely high. Moreover,

the augment of chemical-related alert notifications per year has surpassed the analogous estimation for microbiological causes: ratios between 2011–14 and 1979–90 yearly average values are 2.3 and 3.1 when speaking of microbiological and chemical 'agents' respectively. Substantially, chemical 'menaces' seem to have higher perspectives if evaluated as concern factors.

General sensorial failures and unclear situations have generated 1.2 % of the total number of RASFF alerts (Fig. 2.9): this value was 7.0 % between 1979 and 1990. In addition, yearly amounts can be calculated and compared: 0.3 % in 2011–14 and 0.6 % between 1979 and 1990. Apparently, this result could be interpreted as the natural augment of knowledge when speaking of microbiological and chemical failures at least: in other terms, the higher the explained food safety concerns with a chemical or microbiological feature, the lower the number of unclear situations (without defined explanations). Interestingly, adulteration and fraud episodes reach 0.4 % only (this number was 5.5 % between 1979 and 1990). On the other side, GMO and allergens are perceived as serious menaces: the total number of alerts is 9.8 % in the 2011–14 period (yearly average value: 2.5 %), while the same amount was only 0.5 % between 1979 and 1990. It could be inferred that labeling and nutritional notifications may have an interesting increase in terms of concern because allergens and GMO are often correlated with insufficient or incorrect labeling episodes.

Processing failures reach 5.9 % (the 1979–90 value was 2.0 %). This result is extremely significant because of the increasing importance of process and food packaging failures (Hempel et al. 2012; Parisi 2011, 2012, 2013; Parisi et al. 2016a, b; Wybenga 2001): yearly average data are 0.2 and 1.5 % with relation to 1979–90 and 2011–14 periods respectively.

Finally, the detection of foreign bodies has been recorded 4.9 times on 100 RASFF alert notifications; from the safety viewpoints, it may be affirmed that the 'physical risk' is significantly augmented when speaking of safety perception: yearly average values are 0.1 and 1.2 % in 1979–90 and 2011–14 periods respectively.

As a result, the general comparison of results can be displayed in terms of HACCP-related risks. Table 2.1 shows the tendency of yearly average values of the different 'risk areas' in function of the observation period. Some interesting and surprising results can be highlighted:

(1) Allergens, GMO and novel foods show the most alarming trends (>25.0)
(2) The evolution of foreign bodies is extremely interesting (12.0)
(3) Surprisingly, the increase of processing failures (including food packaging effects and quality control problems, labeling errors, etc.) is more interesting than the 'performance' of chemical and microbiological risks
(4) Adulteration and fraud episodes do not appear so important when speaking of evolution trends, in spite of recent food scandals and the matter of authenticity
(5) The number of 'general sensorial failures' notification is reduced if compared with other risk categories.

Table 2.1 HACCP-related risks and food safety concerns

HACCP-risk and other food safety concern	% Yearly average result (1970–1990)	% Yearly average result (2011–2014)	Ratio between 2011–14 and 1979/90 periods
Microbiological risks	5.0	11.5	2.3
Chemical risks	2.6	8.0	3.1
Foreign bodies	0.1	1.2	12.0
Adulteration and Fraud episodes	0.5	0.1	0.2
General sensorial failures	0.6	0.3	0.5
Processing failures	0.2	1.5	7.5
Allergens/GMO/novel foods	<0.1	2.5	>25.0

Observed trends of yearly average values of different 'risk areas' in function of the observation period

Naturally, the examination concerns only notified situations: however, this study may be helpful because of the possible determination of food safety risks by the HACCP viewpoint on new bases. As a simple example, the role of adulteration and fraud episodes appears reduced if compared with processing failures.

The difficulty of these situations is the possible coexistence of many visible effects and detections of different origin. Undoubtedly, the 'chemical' problem is serious because of the remarkable and constantly increasing amount of chemicals with some role in RASFF alert and non-alert notifications. This difficulty can be easily shown and discussed in Chap. 3. Many analytes and groups of different contaminants are often mentioned in recent alerts and other situations such as border rejections and information communications (European Commission—Health and Food Safety 2015).

2.4 Chemical Risks by the RASFF Viewpoint

In relation to most known and notified chemical risks (chemical contamination and other origins, including microbiological contamination), this list is not exhaustive and concerns chemical contaminants by different origins:

- Metals and related compounds: arsenic, boron compounds, cadmium, chromium, lead, lithium, manganese, mercury, nickel, vanadium
- Oxidising agents: hydrogen peroxide
- Psychoactive compounds: tetrahydrocannabinol
- Food supplements: magnesium aspartate
- Biocontaminants: aflatoxins, histamine, tropane alkaloids
- Amino acids: β-alanine
- Alkaloids: synephrine, yohimbine, vinpocetine, etc.

- Different vitamins
- Pesticides and insecticides: acetamiprid, anthraquinone, carbaryl, carbendazim, chlorpyriphos, 2,2-dichlorovinyl dimethyl phosphate (dichlorvos), ethephon, hexaconazole, imidacloprid, iprodione, profenofos, tebuconazole, etc.

This list shows the prevalence of chemicals with microbiological origin and/or different explanations (contamination, packaging migrations, etc.). With the exception of pesticides, a relevant part of these contaminants seem to be correlated with adulteration/fraud episodes. However, the evolving trend of alert notifications is not apparently serious. Consequently, non-alert notifications—in particular, border rejection notifications—should be studied. Chapter 3 discussed border rejections in detail.

The discussion of most common chemical contaminants is not simple. Probably, a good basis for this discussion may also be the Regulation (EC) No 1881/2006 (Donati 2015) because this document has fixed maximum levels for certain contaminants in foods at the EU level. The following substances have been considered (Donati 2015):

- Nitrate (sodium or potassium nitrate, E251 and E252 respectively)
- Mycotoxins (aflatoxins, ochratoxin A, patulin, deoxynivalenol, zearalenone, fumonisins)
- Metals: cadmium, lead, mercury, (inorganic) tin)
- 3-monochloropropane-1,2 diol esters (3-MCPD)
- Dioxins and dioxin-like polychlorinated biphenyls (PCB)
- Polycyclic aromatic hydrocarbons (PAH).

Table 2.2 shows a list of above-mentioned chemicals and related groups, when possible and applicable, with names, properties, toxicological effects, and contamination sources. Nitrates are used for cured meats to prevent the growth of *Clostridium botulinum* and the related toxin production (Honikel 2008); consequently, they should not be considered 'contaminants' and their role is not discussed here.

However, the attention for many contaminants in the entire food and feed chain has influenced the constant increase of the number of chemical menaces: the following list adds other substances and related classes:

(a) Pesticides: this word covers acaricides, biocides, insecticides, fungicides, herbicides, plant growth regulators, and rodenticides
(b) Veterinary medicines
(c) Radionuclides
(d) Acrylamide
(e) Melamine
(f) Ethyl carbamate.

Table 2.3 shows a list of above-mentioned chemicals and related groups, when possible and applicable, with toxicological effects and contamination sources.

Table 2.2 Chemical risks in the food and feed industry

Chemical risk: substance or group	Chemical name, if available	Toxicological effects	Contamination sources/involved agents
Mycotoxins (see below):			Contaminated food and feed crops (microbiological causes)
	Aflatoxins B_1, B_2, G_1, G_2 and M_1	Human carcinogens and mutagens Other consequences: gastrointestinal diseases Kidney disorders immunosuppressive reducing resistance	Produced by *Aspergillus flavus, A. parasiticus, A. nomius*
	Ochratoxin A	Nephrotoxic agent possible human carcinogen agent genotoxic molecule	Produced by: *Penicillium errucosum, Aspergillus ochraceus, A. niger*
	Patulin	Some immunotoxic and genotoxic effects Alteration of the intestinal barrier function	Produced by several *Aspergillus, Byssochlamys, Paecilomyces, Penicillium* species
	Zearalenone	Different toxic effects have been studied; however, this molecule is potentially dangerous if absorbed in high quantity (alternatively, exposure has to be very long, in temporal terms)	Produced mainly by *Fusarium graminearum* and other *Fusarium* species
	Fumonisins B_1, B_2 and B_3	Liver and kidney tumours (rodents)	Produced by: *Fusarium verticillioides, F. proliferatum*
	Deoxynivalenol (vomitoxin)	Nausea, vomiting, gastrointestinal upset, dizziness, diarrhoea and headache	Produced by: *Fusarium graminearum, F. culmorum*
Metals: arsenic, cadmium, chromium, lead, mercury, (inorganic) tin		Different adverse health consequences: neurologic and neurobehavioral damages; cardiovascular diseases; developmental abnormalities, hearing damages; tumours; hematologic damages	Anthropogenic activities: industrial (food and feed, non-food industries) and farming productions; storage and delivery activities; migration from food-contact materials. Bioaccumulation is demonstrated

(continued)

Table 2.2 (continued)

Chemical risk: substance or group	Chemical name, if available	Toxicological effects	Contamination sources/involved agents
3-monochloropropane-1,2 diol esters (3-MCPD)		Kidney disorders; nephropathy; tubular hyperplasia; adenomas; 3-MCPD is currently considered as a possible carcinogen agent in human beings	By-product of reactions involving glycerol, phospholipids or triacylglycerols on the one hand and hydrochloric acid on the other side. Generally, this situation is observed in fatty foods
Dioxins and dioxin-like polychlorinated biphenyls (PCB)		Different adverse effects including: damages to nervous, immune and endocrine systems; reproductive damages to the reproductive function; tumours	Environmental contaminants with accumulation risks in the food chain. The combustion of industrial o domestic waste materials has been demonstrated
Polycyclic aromatic hydrocarbons (PAH)		Potentially genotoxic and carcinogenic agents in human beings	Environmental contaminants, mainly because of the incomplete combustion of organic matter or different chemicals

Names, toxicological effects, and contamination sources (Creppy 2002; Donati 2015; Logrieco et al. 2002; Peraica et al. 1999; Puel et al. 2010; Shibamoto et al. 2007; Tchounwou et al. 2012)

Table 2.3 Chemical risks correlated to the presence of certain environmental contaminants

Chemical risk: substance or group	Toxicological effects	Contamination sources/involved agents
Pesticides: acaricides, biocides, insecticides, fungicides, herbicides, plant growth regulators, rodenticides, and veterinary medicines	Acute illness effects include: poor concentration, panic attacks, headaches, craps, coma and death (severe situations only) Chronic illness effects include: various cancers, Alzheimer and Parkinson diseases, cardiovascular problems, reproductive damages, asthma	Environmental contaminants: their origin is linked with anthropogenic activities for food production purposes on large scale
Radionuclides	Severe cancer risks cardiovascular disease hereditary consequences	Nuclear accidents and environmental diffusion
Acrylamide	Neurotoxic agent in human beings and animals Possible reproductive damages Carcinogen agent in animals Possible carcinogen agent in human beings	High-temperature reactions between amino acids and carbohydrates. This situation frequently occurs during cooking processes
Melamine	Nephrotoxicity, kidney injury, death	Food adulteration Migration from food-contact plastic materials Contamination by fertilisers
Ethyl carbamate (urethane)	Genotoxic and carcinogen agent in animals Possible carcinogen agent in human beings	By-product of certain fermentation processes in alcoholic beverages

Names, toxicological effects, and contamination sources (Donati 2015; Edwards 1973; Gill and Garg 2014; Hernández et al. 2011, 2013; Hilts and Pelletier 2009; Kamiya et al. 2015; Lee 2013; Rai et al. 2014; Shipp et al. 2006)

Finally, the problem of allergens has to be highlighted. The recent Regulation (EU) No 1169/2011 on the provision of food information to consumers concerns two important points with relation to the EU area:

(a) The mention of allergenic substances on the label of prepacked foods, and
(b) The mandatory mention of allergenic substances when speaking of non-prepacked foods.

In addition, certain quality systems such as the Global Standard for Food Safety, Issue 7, have recently introduced the evaluation of allergen risks when speaking of food lubricants. Obviously, it should be noted that lacking of complete mention of allergens results in production of an unsafe food article.

As a clear result, the definition of most known and cited chemical contaminants, including also allergens, should be provided. At present, the Annex II of the Reg. (EU) No 1169/2011 shows the following list of substances or products with possible allergies or intolerance effects:

- Cereals containing gluten (wheat, rye, barley, oats, spelt, kamut or their hybridised strains), and products thereof, with the following exceptions:
  - Wheat-based glucose syrups including dextrose and wheat-based maltodextrins[2]
  - Glucose syrups based on barley
  - Cereals used for making alcoholic distillates including ethyl alcohol of agricultural origin
- Crustaceans and products thereof
- Eggs and products thereof
- Fish and products thereof, with the exception of:
  - Fish gelatine used as carrier for vitamin or carotenoid preparations
  - Fish gelatine or Isinglass used as fining agent in beer and wine
- Peanuts and products thereof
- Soybeans and products thereof, with the exception of:
  - Fully refined soybean oil and fat (see Footnote 2)
  - Natural mixed tocopherols (E306), natural *D*-alpha tocopherol, natural *D*-alpha tocopherol acetate, and natural *D*-alpha tocopherol succinate from soybean sources
  - Vegetable oils derived phytosterols and phytosterol esters from soybean sources
  - Plant stanol ester produced from vegetable oil sterols (soybean sources)

[2]Please read the original document with relation to this exception.

- Milk and products thereof (including lactose), with the exception of:
  - Whey used for making alcoholic distillates including ethyl alcohol of agricultural origin
  - Lactitol
- Nuts, namely: almonds (*Amygdalus communis L.*), hazelnuts (*Corylus avellana*), walnuts (*Juglans regia*), cashews (*Anacardium occidentale*), pecan nuts (*Carya illinoinensis* (Wangenh.) K. Koch), Brazil nuts (*Bertholletia excelsa*), pistachio nuts (*Pistacia vera*), macadamia or Queensland nuts (*Macadamia ternifolia*), and products thereof, with the exception of nuts used for making alcoholic distillates including ethyl alcohol of agricultural origin
- Celery and products thereof
- Mustard and products thereof
- Sesame seeds and products thereof
- Sulphur dioxide (SO_2) and sulphites at concentrations of more than 10 mg/kg or 10 mg/litre in terms of total SO_2 which are to be calculated for products as proposed ready for consumption or as reconstituted according to the instructions of the manufacturers
- Lupin and products thereof
- Molluscs and products thereof.

The allergen risk is extremely variegated. On the one side, it has to be recognised that immunoglobulin E-mediated food allergy has to be considered as an important chronic disease with different symptoms; sometimes, allergenic substances can be life-threatening for people with food allergy (Muraro et al. 2014). There are not reliable solutions for food allergies; consequently, concerned people have to eat allergen-free foods. On the other side, allergenic substances are ubiquitous components of the whole food and feed chain; as a result, the best strategy appears the rapid communication of used or present allergens in foods. Manufacturers have a difficult responsibility because of the possible cross-contamination between different production lines in the same environment (Allen et al. 2014). For this reason, the monitoring action of RASFF notifications can be very useful, with a special attention to border rejections (Chap. 3).

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Chapter 3
EU Border Rejection Cases: Reasons and RASFF Notifications

Abstract This chapter contains a statistical evaluation of RASFF border rejection notifications. The study concerns the comparison between recorded notifications in two different temporal periods: the four-year 2008–2011 and the subsequent three-year 2012–2014 intervals. The analysis of product categories and hazard categories has been performed with the aim of defining the next 'emerging concerns' from the food safety viewpoint. Moreover, authors have analysed all calculated results with relation to a new risk classification (seven different risk typologies, including adulteration and fraud episodes, processing failures, allergens, and GMO). The comparison between alert and border rejection notifications has been also carried out and discussed in detail.

Keywords Adulteration · Allergens · Border rejection · Chemical risk · GMO · HACCP · Microbiological risk · Physical risk · Processing failures · RASFF

3.1 The RASFF and the Analysis of Notifications: An Overview

The Rapid Alert System for Food and Feed (RASFF) has been created in the European Union with the aim of providing rapid exchange information between European Union (EU) Member States and the European Commission with relation to national controls on food and feed products (European Commission 2009; Paganizza 2013). All important information—also named 'notifications'—concern the detail of food or feed-related risks and correlated measures for the protection of consumers' health, with temporal limits Sect. 2.1.

Notification details have been explained in Sect. 2.1. The classification of these documents has evolved since 1979: at present, three main categories, named

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'original notifications', and two non-original notifications, are publicly available. The classification depends on the associated hazard (Sect. 1.2):

(1) Original notifications: alert notifications, border rejection notifications and information notifications
(2) Non-original notifications: follow-up notifications; other information, also named 'news'.

The analysis of RASFF notifications can be performed with the aim of defining proactively new and emerging food safety risks in the EU area at least (Hruska and Franek 2009; Kleter et al. 2009; Jaud et al. 2013; Zhang et al. 2012). Actually, this investigation should concern the whole RASFF area: member countries are also non-EU Members (Sect. 1.2). Anyway, the analysis of RASFF data is not simple because each notification may be classified in five different ways. Moreover, eight different factors might be classified as interesting food safety hazards (Sect. 2.1).

Chapter 2 has been dedicated to the study of RASFF alert notifications (high risk—rapid actions are required): the examination of these documents has given interesting and surprising results with relation to the evolution of certain hazard categories, according to the RASFF system. On the other hand, most recent information notifications (year 2014) seem to give a slightly different overview, if different hazard categories are discussed (Sect. 2.3). In particular, the problem of adulteration has to be considered with a close attention.

The prevalence of chemicals with microbiological origin and/or chemical explanations (contamination, packaging migrations, etc.) should be explained. With the exception of pesticides (Sect. 2.3), a relevant part of these contaminants seem to be correlated with adulteration/fraud situations when speaking of most recent information notifications in 2014 (European Commission—Health and Food Safety 2015). Consequently, the examination of non-alert notifications with stringent food safety risk implications should be carried out. This chapter discusses the evolution of available data with relation to RASFF border rejections. In particular, the study has concerned the following:

(a) The analysis of most recurrent border rejection notifications and related 'product categories' in the following periods: 2008–2011 (four years) and 2012–2014 (three years)
(b) The analysis of most recurrent border rejection notifications and related 'hazard categories' in the following periods: 2008–2011 (four years) and 2012–2014 (three years)
(c) The discussion of observed differences between the above-mentioned temporal periods
(d) The study of observed concerns by a more specific HACCP viewpoint with the addition of adulteration episodes and other food safety concerns
(e) A brief comparison between obtained results and trends on the one hand, and the most recent overview of hazard categories with relation to information notifications (year 2014) on the other hand.

Statistical elaborations have been made on the basis of RASFF original data. In general, the RASFF Portal[1] can be used to obtain interesting data and give obtained results on the condition that several inputs are given. With reference to our study, the following parameters have been used for research purposes:

(a) Classification of notifications (border rejection)
(b) Hazard category (variable)
(c) Date of notification (interval between two temporal dates)
(d) Product category.

3.2 RASFF Border Rejection Notifications: Food Safety Concerns and Related 'Agents' (2008–2011)

The first border rejection notifications are available since 2008. For evaluation purposes, authors have decided to study the initial situation of most common food safety alerts from an RASFF viewpoint in a relatively short period (2008–2011).

The initial part of statistical evaluations has concerned the composition of food safety notifications with relation to the product category. In detail, the current classification of products is based on three product definitions: food, feed and food contact materials (European Commission—Health and Food Safety 2015). Totally 6163 different border rejection notifications have been considered. Figure 3.1 shows the subdivision of notifications with relation to 39 categories.

In general, the most part of border rejection notifications—72.2 %—are ascribed to the following categories of products (related percentage values are mentioned in brackets):

(1) Nuts, nut products and seeds (33.4 %)
(2) Fruit and vegetables (15.9 %)
(3) Fish and fish products (11.6 %)
(4) Herbs and spices (5.9 %)
(5) Food contact materials (5.4 %).

In addition, the top three product categories can provide 60.9 % of the total amount of border rejection notifications. In other words, the attention of monitoring activities in the EU was surely more when speaking of nuts, fruits, vegetables and fish/seafood products (2008–2011 period). On the other hand, the importance of herb and spices was not high; the same situation concerned also food contact materials (Fig. 3.1).

Interestingly, 19 different product categories show related border rejection notifications below 0.5 %. As a result, it could be inferred that a limited but a

[1]The RASFF Portal can be accessed at the following link: https://webgate.ec.europa.eu/rasff-window/portal/?event=SearchForm&cleanSearch=1.

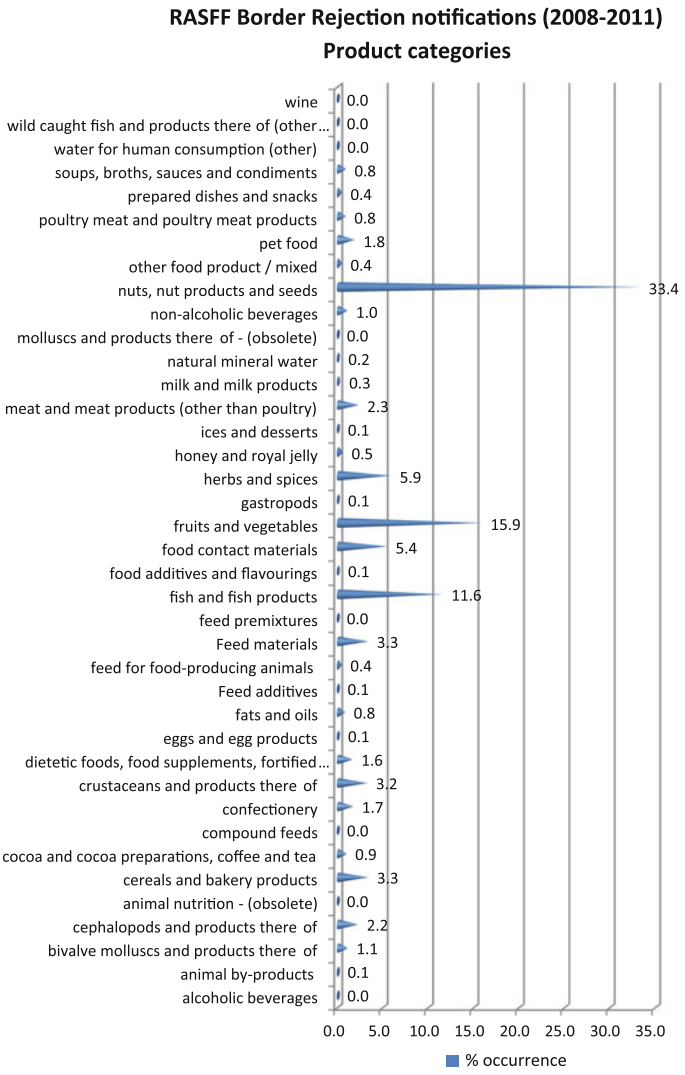

Fig. 3.1 The RASFF and food product categories. Statistical evaluation of border rejection notifications in the 2008–2011 temporal period (four years)

notable importance may be recognised to the following food and feed categories, on the condition that related notifications range between 3.3 and 0.5 % (included):

- Bivalve molluscs and products thereof
- Cephalopods and products thereof
- Cereals and bakery products
- Cocoa and cocoa preparations, coffee and tea
- Confectionery

- Crustaceans and products thereof
- Dietetic foods, food supplements and fortified foods
- Fats and oils
- Feed additives
- Meat and meat products (other than poultry)
- Non-alcoholic beverages
- Pet food
- Poultry meat and poultry meat products
- Soups, broths, sauces and condiments.

Substantially, the main part of food safety concerns in the 2008–2011 period appears mainly linked to foods of vegetable origin (total percentage value: 60.2 %), while foods of non-animal origin are relevant enough (22.7 %) Food contact materials appear to have a good importance (5.4 %) when speaking of the vast and heterogeneous group of 'mixed products' (16.9 %). The first comparison with 1979–1990 data (alert notifications, Sect. 2.2) shows a very different situation: originally, the RASFF mentioned mainly foods of animal origin. On the other hand, certain transformed products—confectionery; 'dietetic foods, food supplements, fortified foods'; prepared dishes and snacks—were not mentioned with notable frequency.

The second part of the study concerns the analytical evaluation of border rejection notifications with reference to hazard categories, as currently defined by the RASFF system (Kleter et al. 2009; Leuschner et al. 2013; Tedesco et al. 2008; Wiig and Kolstad 2005). Figure 3.2 shows the situation in the 2008–2011 period. The most important alerts have been ascribed mainly to the following:

(a) Mycotoxins (38.0 % of total border rejection notifications)
(b) Poor or insufficient controls (7.8 %)
(c) Pesticide residues (6.6 %)
(d) Pathogenic microorganisms (6.1 %)
(e) Heavy metals (5.5 %).

On the other hand, the following hazard categories have not been mentioned or have a low number of border rejection notifications (below 0.5 %):

- Feed additives
- 'Not determined/other'

Basically, the following can be assumed:

(a) The largest part of rejections has concerned high presence of mycotoxins in imported products between 2008 and 2011. The situation has been repeatedly verified. Because of the remarkable frequency (more than one-third of the total number of border rejection decisions are ascribed to mycotoxins), this hazard is surely the first problem when speaking of imported foods before 2012 into the EU
(b) The problem of 'poor or insufficient controls' has to be discussed in the vast ambit of HACCP strategies. Certainly, related notifications concern the world of quality controls

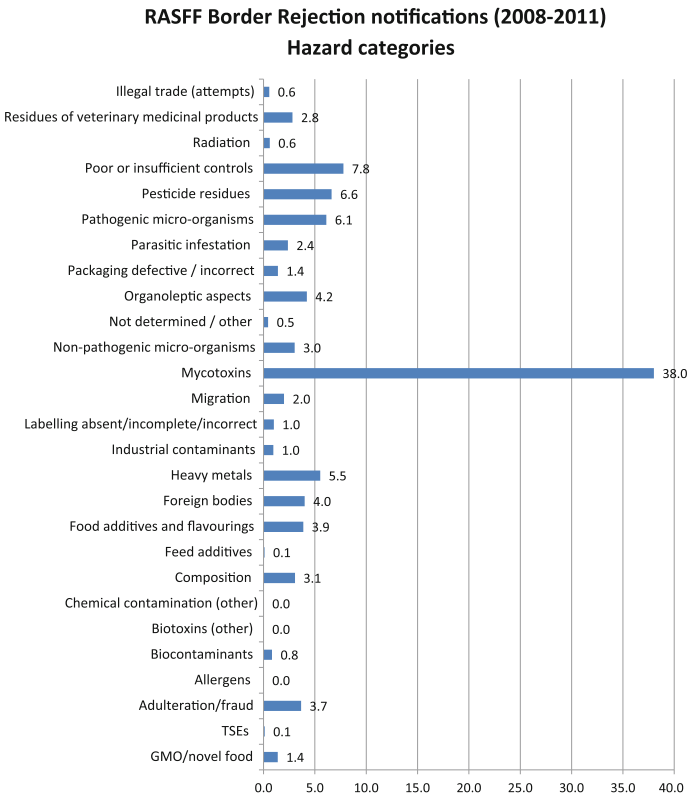

Fig. 3.2 The RASFF and hazard categories. Statistical evaluation of border rejection notifications in the 2008–2011 temporal period (four years)

(c) Pesticides and pathogenic microorganisms are important factors when speaking of preventive public hygiene. The apparently low number is explained by the enormous 'weight' of mycotoxins-related rejections
(d) Heavy metals remain a high concern when speaking of imported foods
(e) One minor category—feed additives—may be defined 'without problems' between 2008 and 2011. In other words, all hazard categories have been notified as cause of border rejection with a certain frequency.

Microbial contamination episodes have been surely discussed broadly in the scientific literature since 1970s (Gordon 1973). For this reason, it may be inferred that the importance of mycotoxins is relatively high. On the other hand, the 'chemical risk' appears to be relevant enough (25.6 %).

- Pesticide residues (6.6 %)
- Heavy metals (5.5 %).
- Food additives and flavourings (3.9 %)
- Composition (3.1 %)

- Residues of veterinary medicinal products (2.8 %)
- Migration (2.0 %)
- Industrial contaminants (1.0 %)
- Radiation (0.6 %)
- Feed additives (0.1 %).

It can be also noted (Fig. 3.2) that

(a) Notifications concerning foreign bodies account for 4.0 %
(b) Adulteration and fraud situations 'weights' 3.7 % if compared with the total number of border rejection notifications.

The list of RASFF hazard categories has been shown in Sect. 2.2. However, HACCP managers could find some difficulties when analysing the whole database for clarification purposes 'as it is'. For this reason, the list of hazard categories could be modified with the aim of providing interested users a sort of HACCP vision of the 'alert' level in the RASFF area.

In other words, the statistical evaluation of most important and recurring alert notifications could be made with the 'translation' of the list of RASFF hazard categories in the following list of 'HACCP risks and other food safety concerns':

- Microbiological risks
- Chemical risks
- Foreign Bodies
- Adulteration and fraud episodes
- General sensorial failures
- Other food safety concerns: processing failures
- Other food safety concerns: allergens, genetically modified organisms (GMO) and novel foods.

The new classification of HACCP risks and other concerns has been explained in Sect. 2.2. The new approach should be comprehensible for HACCP managers and professional auditors facing sectoral concepts in a more simplified way. Consequently, authors have re-elaborated RASFF border rejection notifications between 2008 and 2011: Fig. 3.3 shows the new situation.

Once more, the microbiological risk group appears the most recurring menace: 50.5 % of the total number of border rejection notifications is linked to microbiological food scares. As a result, it can be confirmed that the first level-food menace between 2008 and 2011 was perceived in strict connection with microbiological 'agents'. The same result has been obtained by the analysis of 1979–1990 RASFF alert notifications (Sect. 2.2).

Chemical risks account for 23.6 % of the total amount of alert notifications (Fig. 3.3). Once more, this result confirms the 1979–1990 trend (Sect. 2.2).

Processing failures reach an interesting 12.2 % (when speaking of alert notifications, only 2.0 % of the total number of notifications have been signalled between 1979 and 1990). Probably, this result may depend on two factors:

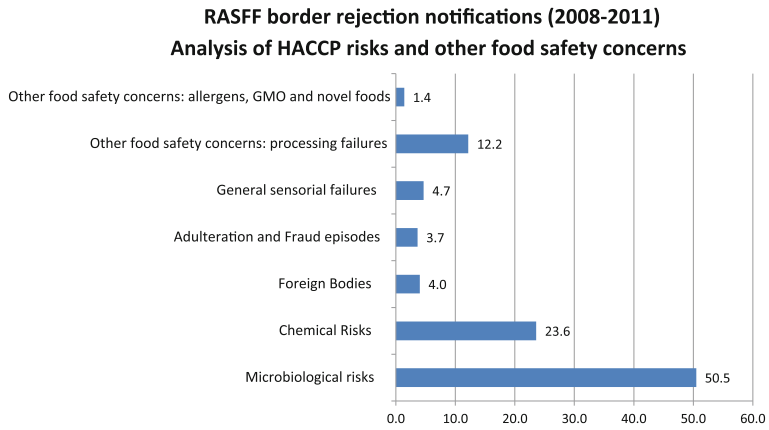

Fig. 3.3 The analytical evaluation of RASFF border rejection notifications (2008–2011) with reference to a new classification: 'HACCP risks and other food safety concerns'. The proposed classification concerns: microbiological risks, chemical risks, foreign bodies, adulteration and fraud episodes, general sensorial failures, other food safety concerns: processing failures, other food safety concerns: allergens, GMO and novel foods

(a) The increased knowledge of certain failures related to food packaging materials and food technology processes
(b) The difference between manufacturing practices of different non-EU countries if compared with EU and RASFF Nations.

General sensorial failures and unclear situations have generated 4.7 % of the total number of RASFF alerts (Fig. 3.3). Interestingly, adulteration and fraud episodes reach 3.7 % while GMO and allergens (Barbieri et al. 2014) have not been perceived as serious menaces between 2008 and 2011 (1.4 %). Finally, the detection of foreign bodies has been recorded 4.0 times on 100 RASFF border rejection notifications; from the safety viewpoints, it could be affirmed that the 'physical risk' (Corlett and Pierson 1992; Corlett and Stier 1991; Hoornstra et al. 2001) has been the cause of many detections when speaking of imported foods.

After this overview of RASFF results between 2008 and 2011, an interesting comparison may be performed with analogous calculated data with relation to the 2012–2014 temporal period.

3.3 Recent RASFF Border Rejection Notifications: Food Safety Concerns and Related 'Agents' (2012–2014)

Because of the necessity of comparing obtained results between 2008 and 2011, authors have decided to study the situation of most common food safety alerts (RASFF border rejection notifications) between 2012 and 2014 (three years).

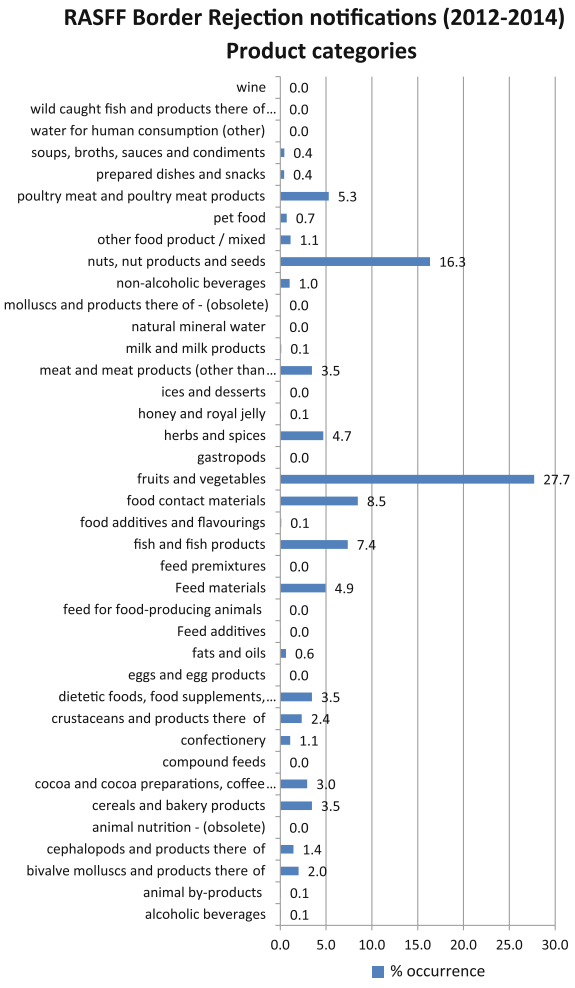

Fig. 3.4 The RASFF and food product categories. Statistical evaluation of border rejection notifications in the 2012–2014 temporal period (three years)

The first part of statistical evaluations has concerned the composition of border rejection notifications (4508 documents) with relation to the product category. Figure 3.4 shows the subdivision of notifications with relation to 39 categories.

In general, the largest part of border rejection notifications are ascribed to the following categories of products (related percentage values are mentioned in brackets):

(1) Fruits and vegetables (27.7 %)
(2) Nuts, nut products and seeds (16.3 %)
(3) Food contact materials (8.5 %)
(4) Fish and fish products (7.4 %)
(5) Poultry meat and poultry meat products (5.3 %).

A first reflection should be made with relation to results of the 2011–2014 analysis of RASFF alert notifications. It could be very interesting to compare these data with the classification of most important food safety hazard between 2011 and 2014 (Sect. 2.3) as follows:

(1) Fish and fish products (14.2 %)
(2) Meat and meat products (other than poultry, 10.8 %)
(3) Fruits and vegetables (10.0 %)
(4) Dietetic foods, food supplements, fortified foods (7.5 %)
(5) Cereals and bakery products (7.3 %)
(6) Food contact materials (6.4 %)
(7) Poultry meat and poultry meat products (5.6 %)
(8) Bivalve molluscs and products thereof (5.3 %)
(9) Nuts, nut products and seeds (4.4 %).

The comparison between above-mentioned lists is interesting because border rejection notifications in the 2012–2014 period are related to non-EU food and feed products only, while alerts concern EU and non-EU products. On these bases, the following hypotheses could be mentioned:

(a) Alerts concerning EU and non-EU fruits and vegetables have significantly lower than notifications for non-EU similar foods. In other words, approximately two-thirds of the total amount of notifications concerning fruits and vegetables are signalled at the EU borders, while the remaining one-third of notifications are signalled into the RASFF area
(b) Food safety risks with notable importance concerning nuts and similar products are notified 16.3 times on 100 border rejection notifications at the EU borders, while the number of signalled problems is only 4.4 % into the RASFF area
(c) 'Food contact materials' and 'poultry meat and poultry meat products' have no peculiar differences if border rejection and alert notifications (percentage values) are compared.

These results could demonstrate the importance of a pre-filtering system at the EU border: in other words, EU borders preventive controls appear to lower the food risk into the RASFF area.

On the other hand, fish and fish products appear to show food safety risks with notable importance into the RASFF area. This result appears in contrast with above-mentioned data. However, it should be noted that the whole RASFF area is composed of many countries with strong interests in the industry of fish and fish products. Consequently, the number of alerts should be predictably higher than the number of food rejection notifications because the RASSF area is able to produce many fish and seafood products. For this reason, pre-filtering controls appear important when speaking of hypotheses. Anyway, fish and fish products appear 'high-risk' products if compared with all remaining hazard categories.

The comparison between the two temporal data sets (Figs. 3.1 and 3.4) can be made by means of the re-elaboration of obtained results as follows. All data displayed in Figs. 3.1 and 3.4 have been re-elaborated with the aim of obtaining a

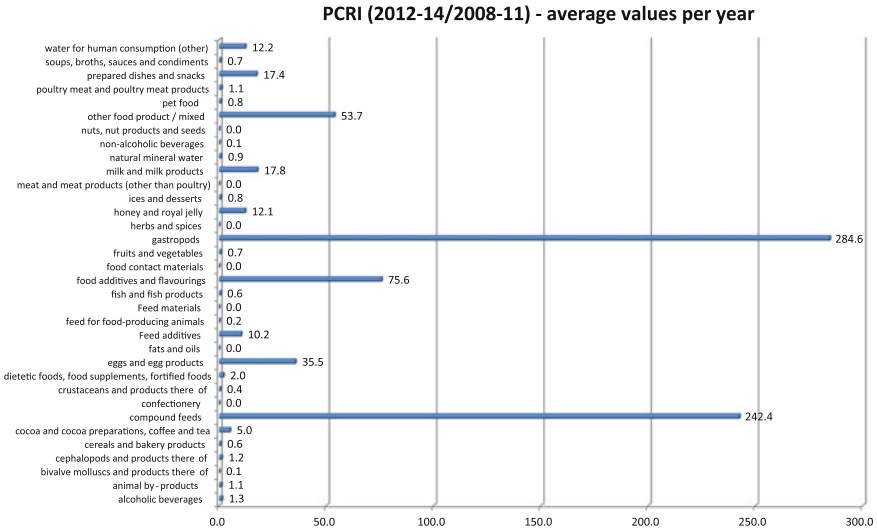

Fig. 3.5 The 'RASFF border rejection ratio index per product category' (PCRI). This number is the ratio between yearly percentage values of RASFF border rejection notifications for a selected product category in 2012–2014 and 2008–2011 periods (Eq. 3.1)

dedicated 'RASFF border rejection ratio index per product category' (PCRI). This number is the ratio between yearly percentage values of RASFF border rejection notifications for a selected product category in 2012–2014 and 2008–2011 periods, as explained in Eq. 3.1

$$\mathrm{PCRI} = \frac{\mathrm{P}_{12-14}}{\mathrm{P}_{08-11}} \tag{3.1}$$

where P_{12-14} and P_{08-11} correspond to yearly percentage values for a specified hazard. It has to be noted that the 2008–2011 period corresponds to four years, while the most recent interval (2012–2014) implies only three years. Recalculated data are shown in Fig. 3.5.

PCRI data show the most interesting products categories as emerging concerns (PCRI values are mentioned into brackets):

(a) Poultry meat and poultry meat products (8.5)
(b) Cocoa and cocoa preparations, coffee and tea (4.3)
(c) Other food product/mixed (3.7)
(d) Dietetic foods, food supplements, fortified foods (2.9)
(e) Bivalve molluscs and products thereof (2.5)
(f) Fruits and vegetables (2.3)
(g) Food contact materials (2.1)
(h) Meat and meat products (other than poultry, 2.0)
(i) Feed materials (2.0).

These categories appear to be under strict observation at present. The meaning of PCRI values should be explained. As an example, the category 'poultry meat and poultry meat products' has a PCRI = 8.5. In other words, the number of border rejection notifications per year (percentage value) with relation to this category has grown up to 8.5 times between 2012 and 2014 if compared analogous with the yearly result between 2008 and 2011. Consequently, Fig. 3.5 seems to show the emerging trend for border notifications in the next years. The role of prepared products (dietetic foods, food supplements, fortified foods; cocoa and cocoa preparations, coffee and tea; other food product/mixed) has to be recognised. At the same time, traditional meat products and vegetable foods remain under strict observation. Food contact materials and feed additives should be also considered.

The second part of the study concerns the analytical evaluation of border rejection notifications with reference to hazard categories, as currently defined by the RASFF system (Sect. 2.3). Figure 3.6 shows the situation in the 2012–2014 period. The most important alerts have been ascribed mainly to the following:

(1) Mycotoxins (21.0 %)
(2) Pesticide residues (20.2 %)
(3) Pathogenic microorganisms (14.7 %)
(4) Heavy metals (7.0 %)
(5) Poor or insufficient controls (5.4 %)
(6) Adulteration/fraud episodes (5.1 %).

The same strategy used for product categories has been also used here with concern to hazard categories. All data displayed in Figs. 3.2 and 3.6 have been re-elaborated with the aim of obtaining a dedicated 'RASFF border rejection ratio index per hazard category' (HCRI). This number is the ratio between yearly percentage values of RASFF border rejection notifications for a selected hazard category in 2012–2014 and 2008–2011 periods, as explained in Eq. 3.2

$$\mathrm{HCRI} = \frac{\mathrm{H}_{12-14}}{\mathrm{H}_{08-11}} \tag{3.2}$$

where H_{12-14} and H_{08-11} correspond to yearly percentage values for a specified hazard. It has to be noted that the 2008–2011 period corresponds to four years, while the most recent interval (2012–2014) implies only three years. Recalculated data are shown in Fig. 3.7.

The examination of obtained values shows some interesting facts as follows:

(a) The emerging risk associated to allergens appears extremely important. In fact, the HCRI value for this hazard (7.3) demonstrates that the associated risk of detection has generated 7.3 times more border rejections in the last years in comparison with 2008–2011. This trend cannot be ignored; however, the number of related notifications between 2012 and 2014 does not exceed seven (one notification between 2008 and 2011). Consequently, allergens have to be considered but the risk should be re-evaluated

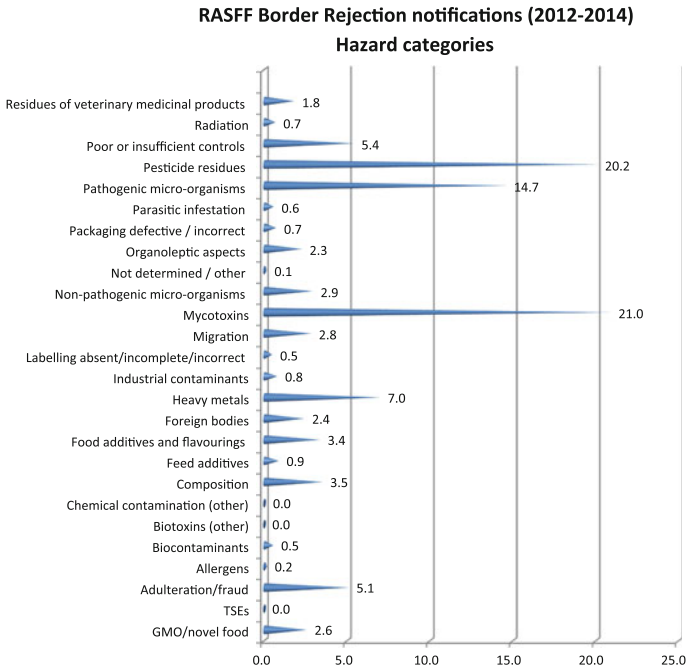

Fig. 3.6 The RASFF and hazard categories. A statistical evaluation of border rejection notifications in the 2012–2014 temporal period (three years)

(b) The same thing can be told with relation to feed additives (HCRI = 6.9). In spite of the high HCRI value, only 40 border rejection notifications are available between 2012 and 2014
(c) HCRI for pesticide residues is relevant (HCRI = 2.1). In addition, more than 930 border rejection notifications have been recorded between 2012 and 2014. Consequently, this hazard has to be considered with extreme concern
(d) With the exception of allergens and feed additives, other high-risk profiles can be assumed when speaking of: pathogenic microorganisms (HCRI = 2.3), chemical contamination (2.1), migration (1.1), heavy metals (1.0), GMO/novel food (1.4) and adulteration/frauds (1.0).

As a result, old and emerging food safety risks may be classified as follows, for predictive purposes:

- Pathogenic microorganisms
- Chemical contamination
- Migration
- Heavy metals
- GMO/novel food
- Adulteration/frauds.

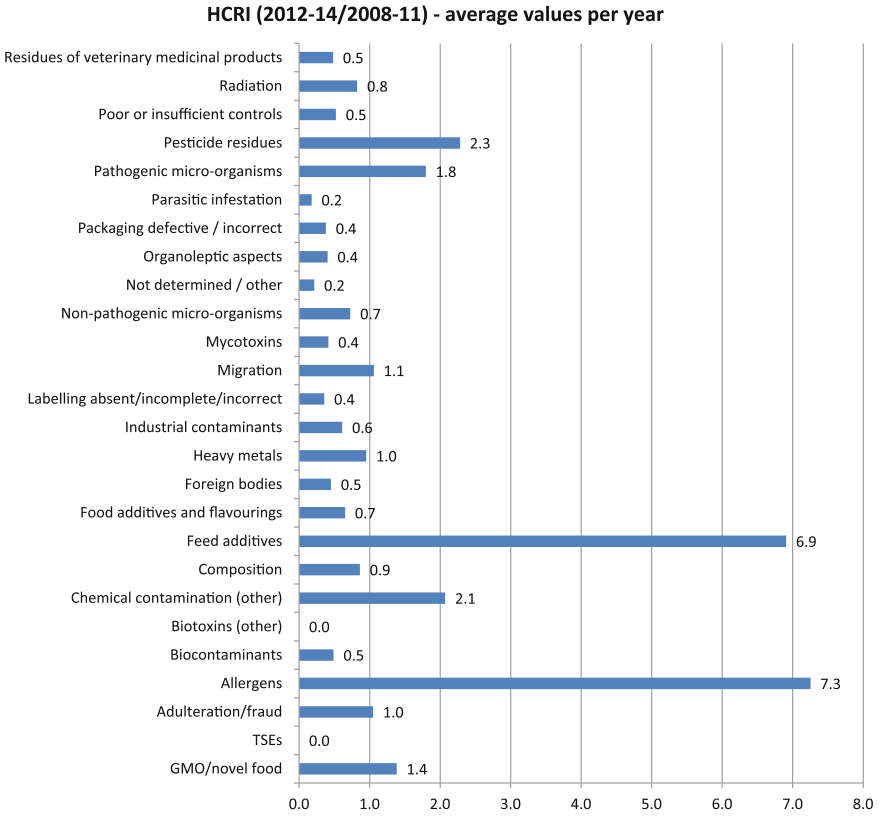

Fig. 3.7 The 'RASFF border rejection ratio index per hazard category' (HCRI). This number is the ratio between yearly percentage values of RASFF border rejection notifications for a selected product category in 2012–2014 and 2008–2011 periods (Eq. 3.2)

Another elaboration of above-mentioned data (2012–2014) may be done with the 'translation' of the list of RASFF hazard categories in the list of 'HACCP risks and other food safety concerns' (Sect. 2.2). Once more, the proposed list mentions the following:

- Microbiological risks
- Chemical risks
- Foreign Bodies
- Adulteration and fraud episodes
- General sensorial failures
- Other food safety concerns: processing failures
- Other food safety concerns: allergens, GMO and novel foods.

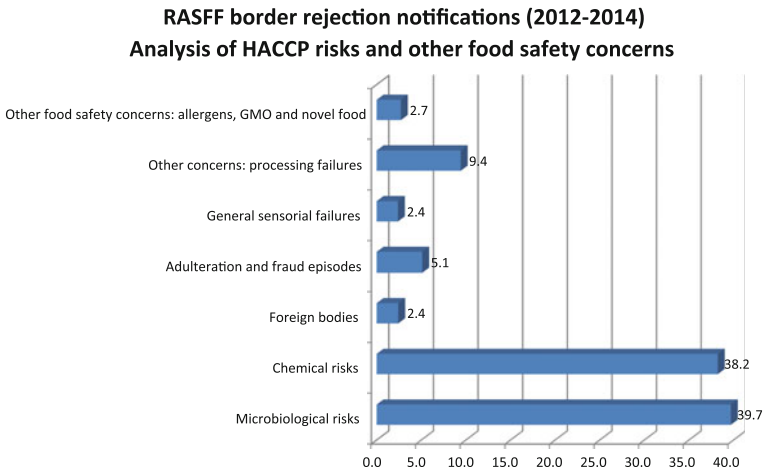

Fig. 3.8 The analytical evaluation of RASFF border rejection notifications (2012–2014) with reference to a new classification: 'HACCP risks and other food safety concerns'. The proposed classification concerns: microbiological risks, chemical risks, foreign bodies, adulteration and fraud episodes, general sensorial failures, other food safety concerns: processing failures, other food safety concerns: allergens, GMO and novel foods

On these bases, calculated data have been re-elaborated and results are shown in Fig. 3.8 with relation to the 2012–2014 time interval.

A brief comparison of Figs. 3.3 and 3.8 shows different variations. The prevailing role of microbiological and chemical risks (50.5 and 23.6 % respectively) between 2008 and 2011 has been discussed. Processing failures are also important (12.2 %) and adulteration episodes are low enough (3.7 %). In contrast, the 2012–2014 interval (Fig. 3.8) shows the reduction of border rejections by microbiological agents (39.7 %) and the remarkable increase of rejections by chemical agents (38.2 %). Moreover, processing failures decrease (9.4 %) and fraud episodes grow up to 5.1 %.

Substantially, the first place is ascribed to microbiological-related notifications; on the other hand, chemical risks reach a remarkable amount of related notifications at present. In addition, the augment of adulteration episodes appears one of the next (and current) emergencies: alert notifications do not seem to highlight this aspect but information notifications appear to confirm the indication of border rejections in 2014 (Sect. 2.3), in accordance with most recent RASFF data (European Commission 2010).

Finally, the detection of foreign bodies has decreased (2008–11: 4.0 %; 2012–2014: 2.4 %); from the safety viewpoints, it may be supposed that the 'physical risk' is reduced enough in recent years.

These conclusions may be used to draw (Chap. 4) a reliable prediction for the next years in terms of food safety and risk perception in the whole RASFF area.

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Chapter 4
Conclusions and the Future of the RASFF

Abstract This chapter offers an outlook on the future of the rapid alert system for food and feed (RASFF) system and possible expectations. The influence of market needs on RASFF records is notable. In addition, the statistical study of RASFF documents (alerts and border rejection notifications above all) and the analysis of emerging trends may help the analysis of food safety risks in other ambits such as the new 'Food Safety Modernization Act' in the United States of America. In general, the scarcity of certain products in the RASFF area with the consequent and increasing need of imported materials seem to important factors when speaking of high-risk product categories and the correlated monitoring level. With concern to hazards, allergens and GMO appear as the 'emerging' hazard for the next years, while adulteration and fraud episodes appear to be recurrent menaces; as a result, a strict surveillance is required with the aim of overburdening the inspection capacity of official controls across the whole RASFF area.

Keywords Adulteration · Alert · Border rejection · Emerging safety concerns · Food business operator · FSMA · HACCP · Preventive control · RASFF

4.1 RASFF Notifications and Emerging Concerns. A Brief Summary

The rapid alert system for food and feed (RASFF) has been created in the European Union with the aim of providing rapid exchange information between European Union (EU) Member States and the European Commission with relation to national controls on food and feed products (Sects. 2.1 and 3.1). All important information—also named 'notifications'—concern the detail of food or feed-related risks and correlated measures for the protection of consumers' health, with temporal limits.

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Chemistry of Foods, DOI 10.1007/978-3-319-33393-9_4

Notification details have been explained in Sect. 2.1. At present, the classification of these documents is based on the subdivision in three main categories, named 'original notifications', and two non-original notifications. Original notifications—alert, border rejection, and information documents—are the basis of the current RASFF system. In addition, 'non-original' notifications—follow-up notifications and 'news'—are also available (Sect. 2.1).

The basic aim of this book has been the study of existing RASFF notifications since 1979. The statistical elaboration of considered data has allowed targeting the next possible concerns in the EU when speaking of food safety and public hygiene. Different studies have been conducted with this objective so far (Kleter et al. 2009; Marvin et al. 2009; Petroczi et al. 2011). This work has analysed different and limited historical periods with the aim of examining emerging trends of RASFF notifications since 1979. Additionally, a predictive approach has been considered because of the clear similarity between notified food and feed safety risks on the one hand and the increasing complexity of food and feed markets, in terms of availability of many different product categories.

Chapter 2 has been dedicated to the study of RASFF alert notifications (high risk—rapid actions are required): the examination of these documents has given interesting and surprising results with relation to the evolution of certain hazard categories, according to the RASFF system. Furthermore, most recent information notifications (year: 2014) seem to give a slightly different overview, if different hazard categories are discussed (Sect. 2.3). In particular, the problem of adulteration has to be considered with high attention. The analysis has allowed the definition of most important food and feed products with important safety and hygiene risks. Moreover, most emerging 'problems' have been discriminated by means of two different approaches:

(a) The statistical evaluation of percentage alert notifications with relation to two different periods: 1979–1990 (eleven years) and 2011–2014 (four years). Thirty nine different hazard categories have been considered, according to the RASFF classification
(b) The statistical evolution of percentage alert notifications (yearly average results) as stated above (1979–1990 and 2012–2014 time intervals). A new classification of risks, based on the Hazard analysis and critical control points' (HACCP) approach has been proposed.

The second part of the whole examination has concerned the analysis of RASFF border rejection notifications (Chap. 3). Once more, border rejections occur if a significant food safety risk is detected (high level). Obtained results have allowed obtaining a good classification with relation to rejected food and feed commodities with important food safety hazards. The evolution of RASFF notifications is clearly aligned with the complexity of food and feed productions. In addition, most emerging food safety risks and other concerns have been highlighted by means of two different strategies, as discussed in Chap. 2.

In general, the global comparison of obtained results can give some interesting information. It should be observed that two types of notifications have been considered

(a) Alert notifications: They imply significant food safety hazard and the necessity of rapid actions
(b) Border rejection notifications. These documents concern the detection of food safety risks before the physical entering of food and feed commodities into the EU and the European Economic Area (EEA) market.

Border rejection notifications may assume a precise meaning: the demonstration of a first-level (preventive) control on food safety risks. In fact, the execution of preventive tests on non-EU food and feed products can act as a sort of 'pre-filtering' system. On the other hand, alert notifications may be considered as the result of a second-level testing control on a limited number of EU and non-EU products because of the preventive limitation of the whole quantity of food and feed commodities on the market.

On these bases, the following results have been expressed as 'alert' and 'border rejection' classifications

(1) The evolution of emerging trends with relation to alert notifications (these documents concern only the detection of safety risks with high importance into the EU and EEA area, on EU, and non-EU products) appears to highlight the following product categories (alert classification):

    – Fish and fish products
    – Dietetic foods, food supplements, and fortified foods
    – Cereals and bakery products
    – Nuts, nut products, and seeds
    – Meat and meat products (poultry and similar products are excluded)
    – Fruits and vegetables
    – Food contact materials
    – Bivalve molluscs and products thereof
    – Milk and milk products
    – Poultry and similar products.

    This classification is based only on the augment of percentage values, when data are available (some category was not described and notified until 1990). For this reason, related positions should not be considered with presumption of accuracy. In other words, this classification is purely hypothetical and for predictive purposes only.
(2) The evolution of emerging trends with relation to alert notifications appears to highlight the following hazard categories (Figs. 2.3 and 2.8).

    – Allergens
    – Mycotoxins
    – Foreign bodies

- Heavy metals
- Pathogenic microorganisms
- Composition

From the HACCP viewpoint, the following food safety risks and other concerns may be detected as emerging 'problems'

- Allergens/genetically modified organisms (GMO)/novel foods
- Foreign bodies
- Processing failures
- Chemical risks
- Microbiological risks
- General sensorial failures
- Adulteration and fraud episodes.

(3) The evolution of emerging trends with relation to border rejection notifications (these documents concern the detection of safety risks at the EU borders on non-EU products only) appears to highlight the following product categories (border rejection classification):

- Poultry meat and poultry meat products
- Cocoa and cocoa preparations, coffee and tea
- Other food product/mixed
- Dietetic foods, food supplements, fortified foods
- Bivalve molluscs and products thereof
- Fruits and vegetables
- Food contact materials
- Meat and meat products (other than poultry)
- Feed materials.

(4) The evolution of emerging trends with relation to border rejection notifications appears to highlight the following hazard categories (border rejection classification):

- Pathogenic microorganisms
- Chemical contamination
- Migration
- Heavy metals
- GMO/novel food
- Adulteration/frauds.

From the HACCP viewpoint, the following food safety risks and other concerns may be detected as emerging 'problems'

- Allergens, GMO and novel food
- Chemical risks
- Adulteration and fraud episodes
- Microbiological risks

- Processing failures
- Foreign bodies
- General sensorial failures.

The comparison of these data may be useful if used as a preventive tool for establishing new safety procedures in food and feed companies and interested players of the food and feed chain.

4.2 RASFF Notifications. Emerging Product and Hazard Categories

The activity of hygiene controls in EU and EEA Countries may be considered in terms of alert notifications. On the other side, results of the preventive approach to food safety risks may be considered in the EU by the viewpoint of RASFF in terms of border rejection notifications (Figs. 4.1 and 4.2).

For these reasons, the two types of notification documents may easily yield different results when speaking of statistical elaboration and predictive results. Probably, several confirmations can be obtained if results are compared with the

Fig. 4.1 RASFF notifications and product trends. 'Alert' and 'border rejection' classifications are considered on the basis of the comparison of the frequency of notification for each product category. Positions in each list correspond to predictive indicators without presumption of strict accuracy. Consequently, the meaning of these lists is correlated with the individuation of emerging trends in the next years

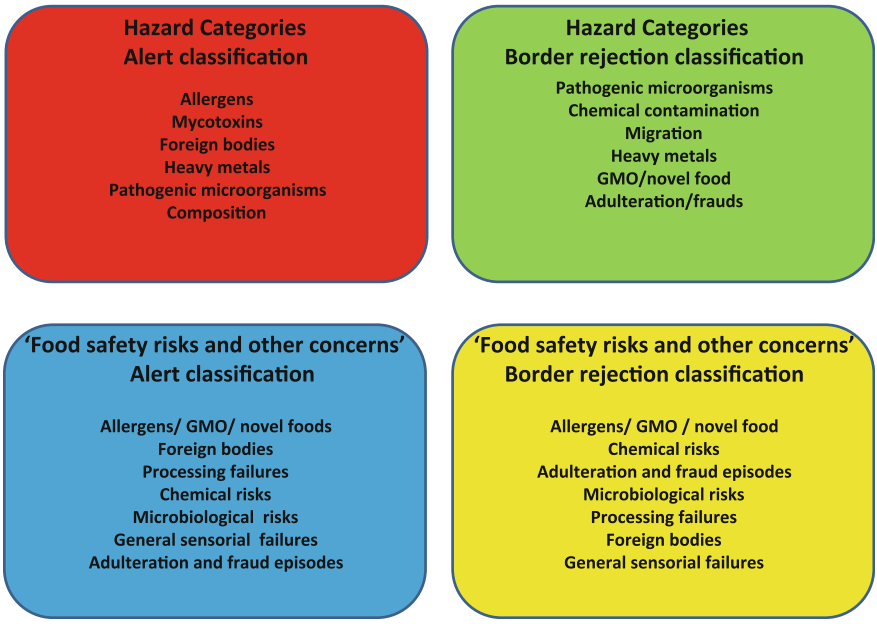

Fig. 4.2 RASFF notifications and hazard trends. 'Alert' and 'border rejection' classifications are considered on the basis of the comparison of the frequency of notification for each product category. Positions in each list correspond to predictive indicators without presumption of strict accuracy. Consequently, the meaning of these lists is correlated with the individuation of emerging trends in the next years

whole mass of RASFF notifications (Sect. 2.1). In fact, data from alert notifications have highlighted the role of several hazard categories (Sect. 2.3), but RASFF documents in 2014 seem to show a dissimilar framework. In detail, the 'little' importance of certain hazards such as adulteration and fraud episodes (alert notifications) appears questionable if RASFF data are considered in 2014 (European Commission—Health and Food Safety 2015): interestingly, the role of adulteration seems important enough. For this reason, the initial study has considered border rejections also.

4.2.1 Emerging Products Categories

With relation to the analysis of the most important food and feed categories (according to statistical trends), it may be considered that

(1) The position of fish and fish products is extremely important when speaking of EU internal controls (alert notifications). On the other hand, border rejection notifications appear to mention this category with a lower frequency in the last

years. Probably, the amount of EU-produced fish and seafood is the main reason for these contrasting results. Cereals and bakery products seem to show the same situation. On the contrary, bivalve molluscs and similar products are not so important in both categories

(2) The category 'dietetic foods, food supplements and fortified foods' is ranked second when speaking of EU internal controls and third when speaking of non-EU commodities. Substantially, this category is 'under strict surveillance'; the origin of inspected foods does not matter

(3) Nuts, nut products, and seeds are ranked fourth when speaking of alert notifications; on the other hand, border rejections appear to mention these products with lower frequency in the last years. Interestingly, this category of products was not mentioned between 1979 and 1990 and should be considered as an 'emerging' food with possible safety concerns

(4) Meat and meat preparations seem under strict surveillance in the EU & EEA market, while poultry does not seem so important. These positions are completely different when speaking of border controls: poultry and similar products are frequently rejected, while meat and meat preparations are ranked eighth only when speaking of border controls

(5) Fruits and vegetables appear to have the same importance in both classifications. Food contact materials are in a similar situation

(6) Milk and milk products are mentioned with a good frequency in the last years with concern to internal controls; on the other side, they are not frequently rejected

(7) Three products categories are not mentioned in alert notifications with notable frequency in the last years, while their importance is 'high' when speaking of border rejections: 'cocoa and cocoa preparations, coffee and tea,' 'other food product/mixed,' and 'feed materials'. Probably, this situation depends on the scarcity of similar products in the EU & EEA market and the consequent and increasing need of imported materials.

Consequently, it can be noted that the influence of market needs on RASFF records is notable and should be studied. In addition, there is the possibility that similar results may help the analysis of food safety risks in other ambits such as the new 'Food Safety Modernization Act' (FSMA) in the United States of America (USA). This reflection might be useful because the FSMA concerns domestic and foreign producers of edible commodities (Bhagat et al. 2016); because of the scarcity of some food raw materials in the USA, it could be anticipated that the higher the amount of imported foods, the lower the importance of certain food categories and food safety hazards in future.

4.2.2 Emerging Hazard Categories

With relation to the analysis of the most important hazard categories (according to statistical trends), it may be considered that

(1) The position of allergens, mycotoxins and heavy metals are relevant when speaking of alert notifications, but these categories are out of the first six places in the 'border rejection' classification. On the other hand, GMO and novel foods are mentioned with a notable frequency in the last years
(2) The physical risk is extremely important in both classifications
(3) The position of pathogenic microorganisms is relevant when speaking of rejected goods, while the related danger is ranked fifth only when speaking of EU internal controls
(4) 'Chemical contamination,' 'migration,' and 'adulteration/frauds' are placed second, third, and sixth, respectively, in the 'border rejection' classification. The importance of adulteration and fraud episodes is constantly increasing; this reflection has to be taken seriously into account. In fact, the last RASFF report (European Commission—Health and Food Safety 2015) has mentioned different fraud episodes, in apparent contrast with the analysis of alerts only (without other original notifications).

Because of the complex analysis of hazard categories, the statistical examination of alert and border rejection data can be performed with the alternative list of 'HACCP risks and other food safety concerns'. By this viewpoint, two different alert and border rejection classifications are available (Sect. 4.2). The comparison of these lists shows that

(a) The group of 'Allergens/GMO/novel foods' is ranked first in both classifications. Differently from the above mentioned description of hazard categories, the new comparison demonstrated that allergens, GMO and novel foods may be considered part of a distinct category and 'dominate' alert and border rejections in terms of emerging trends
(b) Foreign bodies (physical risk) appear important when speaking of EU internal controls (alert notifications), while the related trend seems to be less important for rejected commodities. The same thing may be noted for 'processing failures'; however, this category is extremely variegated
(c) Chemical risks appear slightly more important as cause of border rejection
(d) Microbiological risks are ranked fifth and fourth in alert and border rejection classifications, respectively. In other words, the microbiological danger diventa remains moderately important
(e) General sensorial failures do not seem so important
(f) Finally, adulteration episodes are ranked sixth only when speaking of EU internal controls; on the other side, they are third in the 'border rejection' classification. This result seems to highlight the importance of preventive controls at EU and EEA borders.

On these bases, it can be assumed that allergens and GMO are the 'emerging' hazard for the next years, while adulteration and fraud episodes appear to be

recurrent menaces; as a result, a strict surveillance is required at the EU and EEA borders with the aim of overburdening the inspection capacity of official controls across the whole RASFF area.

4.3 The Future of the RASFF System

The RASFF system can be efficacy used as a powerful instrument for prediction purposes, when speaking of public health and food safety in the EU and the EEA. This book is dedicated to the aim of providing a reliable analysis of most recurrent food safety hazards with the additional possibility of predictive tools for risk assessment.

With relation to the next years, the RASFF's mission is certainly correlated with the limitation of the amount of contaminated food and feed products in the EU and EEA area. In addition, the number and the quantity of rejections at borders should be significantly reduced (European Commission 2009). However, because of the necessity of making many efforts in the EU and in non-EU-Countries (the role of extra-European Nations concerns exporting activities), it should be predicted that the cooperation between RASFF Countries and non-RASFF Members becomes stricter in the next future. This collaboration concerns surely scientific data, the role of possible international working groups, and the enhancement of existing instruments, including electronic platforms.

From the viewpoint of non-RASFF Countries, the role of RASFF may somewhat be seen as a barrier to normal trades but sure beneficial effects should also be evident (Çobanoğlu 2013). The FSMA approach that includes continuous monitoring and scientific advice by all interested stakeholders and might take advantage of this reliable analysis of recurrent food safety hazards with possible predictive tools for risk assessment.

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