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Comparative analysis of notifications regarding mycotoxins in the Rapid Alert System for Food and Feed (RASFF)

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RESEARCH ARTICLE

Abstract

Mycotoxins were the most frequently reported hazard category in the Rapid Alert System for Food and Feed (RASFF) in 1981-2017. The study included notifications regarding mycotoxins based on the RASFF database using pivot tables in Excel and cluster analysis in Statistica 12. The following variables were taken into account: notification year, product category, notifying country, country of origin, notification basis, notification type, distribution status, risk decision and action taken. There were also presented mycotoxins in reports of other institutions, reduction of the hazards of mycotoxins and remarks related to data on mycotoxins from the RASFF database.

Keywords: food safety, pivot tables, cluster analysis, border rejections, information notifications

1. Introduction

Mycotoxins as toxic metabolites of fungi (Alldrick *et al.*, 2009a,b; Thomson *et al.*, 2012) are contaminants. In European law a contaminant is defined as any substance not intentionally added to food which is present in such food as a result of production, manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food, or as a result of environmental contamination (EU, 1993).

Bullerman and Bianchini (2007) highlighted that mycotoxins are stable compounds and are not completely destroyed during food processing operations. Unfortunately, climate changes affect the presence of mycotoxins in food. It is mainly associated with various impacts of warmer weather, heat waves, greater precipitation and drought, and it also depends on the world region and the mycotoxin in question (Paterson and Lima, 2011). Particular attention is often paid to higher temperature and humidity, posing a risk of concentration of mycotoxins in food products (Havelaar *et al.*, 2010; Kleter and Marvin, 2009; Miraglia *et al.*, 2009; Paterson and Lima, 2011).

Alldrick *et al.* (2009a) noted that presence of mycotoxins in food is only permitted if contamination levels (European Commission, 2006) do not immediately compromise public health or if they do not cause toxicological problems, or if their presence is unavoidable after following best practice. However, mycotoxins were the most frequently reported hazard category in the Rapid Alert System for Food and Feed (RASFF), constituting about 21% of all notifications from 1981 (the date of the first mycotoxin notification in the RASFF) to the end of 2017. The other frequently reported hazard categories were pathogenic micro-organisms (19%), pesticide residues (8%), heavy metals (7%) and composition (5%) (European Commission, 2018c).

The RASFF was created in 1979 and enables the flow of information on risks to public health which were detected in the food and feed chain. Currently, the legal basis for the RASFF is Regulation 178/2002, laying down general principles and requirements of food law, establishing the European Food Safety Authority and procedures of food safety (European Parliament and Council, 2002; European Commission, 2018b). The implementing measures for this system were included in Regulation 16/2011 (European Commission, 2011). The information in the RASFF is exchanged between its members, i.e. national food safety authorities of 28 European Union (EU) countries, the European Commission, the European Food Safety Authority, the European Free Trade Association Surveillance Agency,

Norway, Liechtenstein, Iceland and Switzerland. Alert notifications are sent when food or feed presenting a serious health risk is on the market and rapid action (e.g. withdrawal from the market) is required. Information notifications relate to risk concerning food or feed on the market but the other members do not have to take any rapid action, because the product has not reached their market, is no longer present on their market or because of the nature of the risk. Border rejections relate to food and feed in which a health risk has been found after testing and the consignment was rejected at the external border of the European Economic Area (EEA). The notification is sent to all EEA border posts to avoid this product re-entering the EU through another border post (European Commission, 2018b).

However, the views on the usefulness of the RASFF are varied. Bánáti (2011) stated that the RASFF is not able to prevent contaminated food from entering the food chain and the market. Van de Brug *et al.* (2014) noted that RASFF is primarily based on existing knowledge and is not designed to identify new or unexpected hazards. Marvin *et al.* (2009) pointed out that, when signalled to the RASFF, problems have already occurred so this system cannot be considered as a preventive measure. It is useful in product recalls (Dabbene *et al.*, 2014; Marvin *et al.*, 2009; Wynn *et al.*, 2011; Zach *et al.*, 2012) and detention of imports (Marvin *et al.*, 2009). Moreover, Orford *et al.* (2014) noted that the data collected in the RASFF are not standardised or coded, which hinders exchange of data with other systems.

Marvin *et al.* (2009) added, however, that observing trends of increasingly more frequent notifications on hazards in certain products combined with information on the potential impact of health and trade can be used to identify hazards that are likely to increase in future. Petróczi *et al.* (2010) even stated that the RASFF can be applied to forecast and construct a prediction engine that will enable a real-time analysis. In turn, Székács *et al.* (2018), on the basis of data from the RASFF, proposed a risk matrix covering the severity of adverse effects and the probability of exposure.

In the middle of each year the European Commission issues the annual RASFF report for the previous year (European Commission, 2018b). However, these reports present notifications on mycotoxins in simplified and general ways. Therefore, the goal of this study was to perform a comparative analysis of RASFF notifications on mycotoxins taking into account notification year, product category, notifying country, country of origin, notification basis, notification type, distribution status, risk decision and action taken, directly based on the RASFF database.

2. Data and methods

The data originated from the RASFF database and concerned 10,912 notifications from 1981 to 2017. The data were collected in Excel with regard to the product type (food and feed) and the following variables: mycotoxin type, notification year, product category, notifying country, country of origin, notification basis, notification type, distribution status, risk decision and action taken. Both for food and feed, mycotoxins with the percentage of notifications above 5% and with values above the mean value are discussed.

The data from the RASFF database were processed in pivot tables in Excel and then transferred to the Statistica 12 program (Tulsa, OK, USA), where a cluster analysis was applied using the two-way joining method (contour charts in Supplementary Material). These charts allowed presentation of similarities between particular mycotoxins and values of other variables. Contours become denser and simultaneously change colour (from green, through yellow, orange and red, to brown), concentrating on clusters with increasing number of notifications. In each chart mycotoxin types were given on the X axis and values of the other variables on the Y axis. The reason for using two-way joining method was the expectation that both mycotoxins and the above-mentioned variables would simultaneously form meaningful cluster patterns. In the case of long names of the values they were shortened in charts and explained below them.

The detailed analysis of notifications of mycotoxins in the RASFF database was hindered due to the lack of data, particularly in the case of earlier years, in which the mycotoxin type was not specified. The lack of data was also related to other variables, i.e. notification basis, country of origin, distribution status and action taken. In these cases the phrase '(not specified)' was adopted. Also, if more than one mycotoxin was reported in the notification, only the first mycotoxin listed was adopted. A similar procedure was followed when more than one country of origin was reported (however, in almost all cases there was only one country of origin). The use of such an approach was necessary for statistical analysis. Interpretation of the data was also difficult due to changes in the notification type, i.e. information notification since 1989, information for follow-up since 2010, information for attention since 2011 and border rejection since 2008. Moreover, the risk decision was very often indicated as 'undecided', which may raise particular doubts in the case of alert notifications or border rejections.

In the figures, the following abbreviations were used for product categories: cereals – cereals and bakery products; cocoa, coffee, tea – cocoa and cocoa preparations, coffee and tea; fruits, vegetables – fruits and vegetables; herbs, spices – herbs and spices; nuts, seeds – nuts, nut products and seeds. For distribution status the following abbreviations were used: distr. to m. countries – distribution to other member countries; distribution (possible) – distribution on the market (possible); distribution restricted – distribution

restricted to notifying country; not placed on market – product not (yet) placed on the market.

3. Results

About 96% of notifications on mycotoxins in the RASFF concerned food and only about 4% referred to feed. The largest number of notifications was related to aflatoxin B1 (AFB_1; 8,784; 80%), aflatoxins (not specified) (1,376; 13%) and ochratoxin A (OTA; 550; 5%). The notifications concerning other mycotoxins were also related to fumonisins and deoxynivalenol (between 0.5 and 1%) and also to aflatoxin M1, citrinin, patulin, T-2 and zearalenone (below 0.5%) (European Commission, 2018c).

In 2004 and 2005, a clear increase in the number of notifications for food was observed for AFB_1, when official controls were introduced on the market. These controls were made on the basis of Regulation 852/2004 on hygiene of foodstuffs (European Parliament and Council, 2004a) and 882/2004 on official controls (European Parliament and Council, 2004b), which was repealed by Regulation 2017/625 also on officials controls (European Parliament and Council, 2017). Simultaneously, after 2003/2004 a decrease in the notification number of aflatoxins (not specified) can be observed, because the mycotoxin type began to be recorded in the RASFF. After a decrease in the number of notifications for AFB_1 in 2006 and 2007, an increase occurred in 2008 again, when border rejections began to be noted in the RASFF. After 2008 the number of notifications on mycotoxins in food systematically decreased until 2013/2014, when an increase can again be observed. However, a particularly high number of notifications for food can be observed in 2004, 2005, 2007 and 2008 (for AFB_1), in 2003 (for aflatoxins – not specified) and in 2006, 2013 and 2016 (for OTA) (Figure 1 and Figure S1) (European Commission, 2018c).

The notifications on mycotoxins related mainly to nuts, nut products and seeds for AFB_1 and aflatoxins (not specified) and to fruits, vegetables, herbs and spices for AFB_1. Ochratoxin A was also reported in fruits, vegetables, herbs and spices (Figure 2 and Figure S2). Products with AFB_1 and aflatoxins (not specified) were reported mainly by Germany, Italy, Netherlands, Greece, Spain and United Kingdom, while Germany, Netherlands and Italy reported products with OTA (Figure 3 and Figure S3). Iran, Turkey and China were reported as the countries of origin of products with AFB_1 and aflatoxins (not specified). Ochratoxin A was the most frequently reported mycotoxin in products originating from Turkey (Figure 4 and Figure S4). The notification basis for the products containing AFB_1 and aflatoxins (not specified) were mostly border control, after which the consignment was detained. Therefore, the notification type was mainly border rejection and also information. However, in the case of OTA the notification basis was mainly official controls on the market (products were already on the European market) and the notification type was alert or information. Moreover, there were also border controls, after which consignments were detained. The products with AFB_1 were not distributed or not (yet) placed on the market, and the distribution status for products with aflatoxins (not specified) was not specified either. Distribution of products with OTA was restricted to the notifying country or these products were not distributed (Figure 5 and Figure S5). The decision regarding risk in the

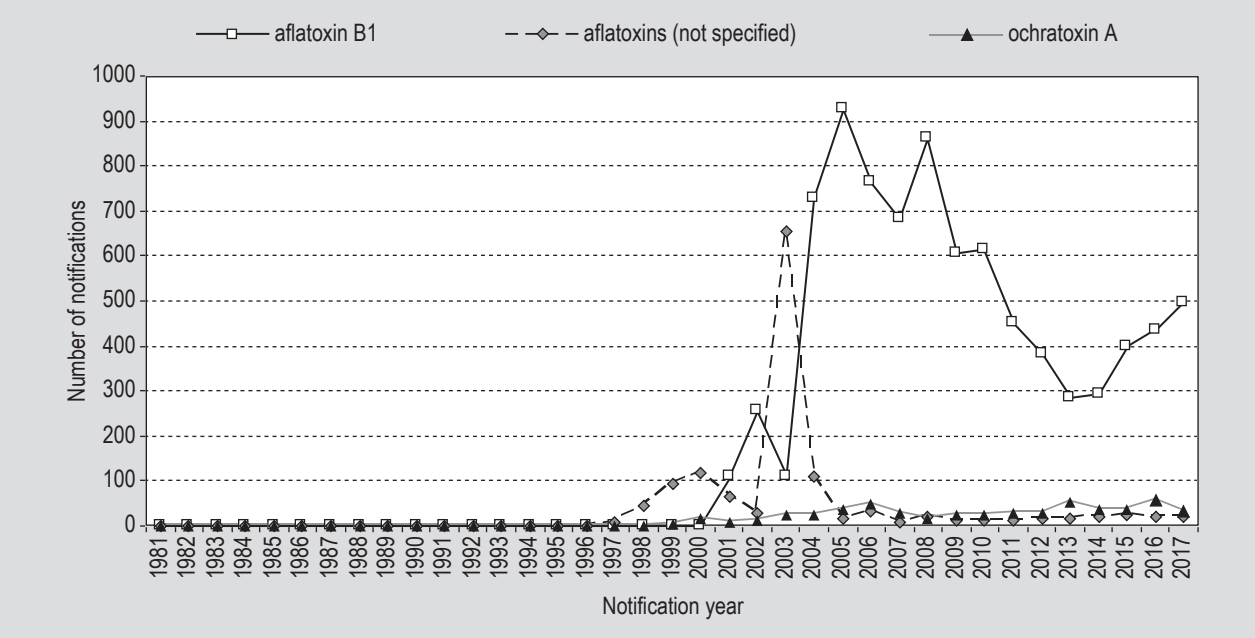

Figure 1. Number of RASFF notifications on mycotoxins in food according to year.

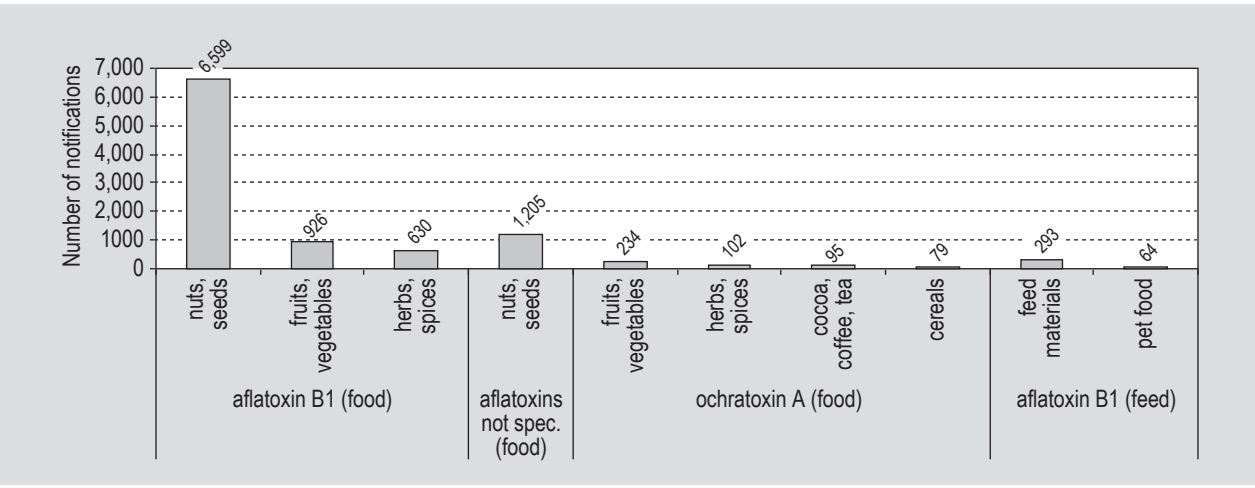

Figure 2. Number of RASFF notifications on mycotoxins in food and feed according to product category.

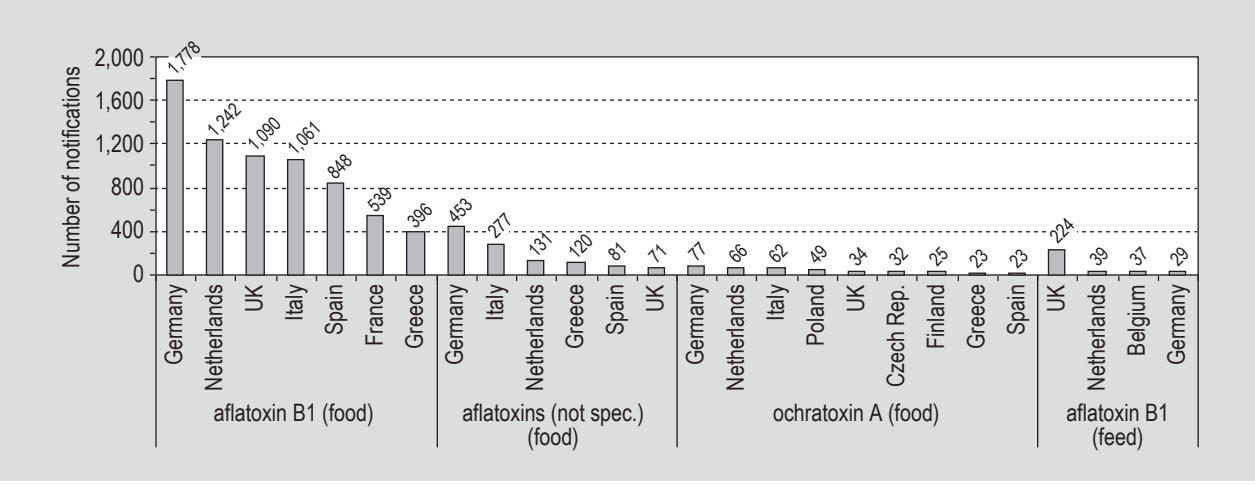

Figure 3. Number of RASFF notifications on mycotoxins in food and feed according to the notifying country.

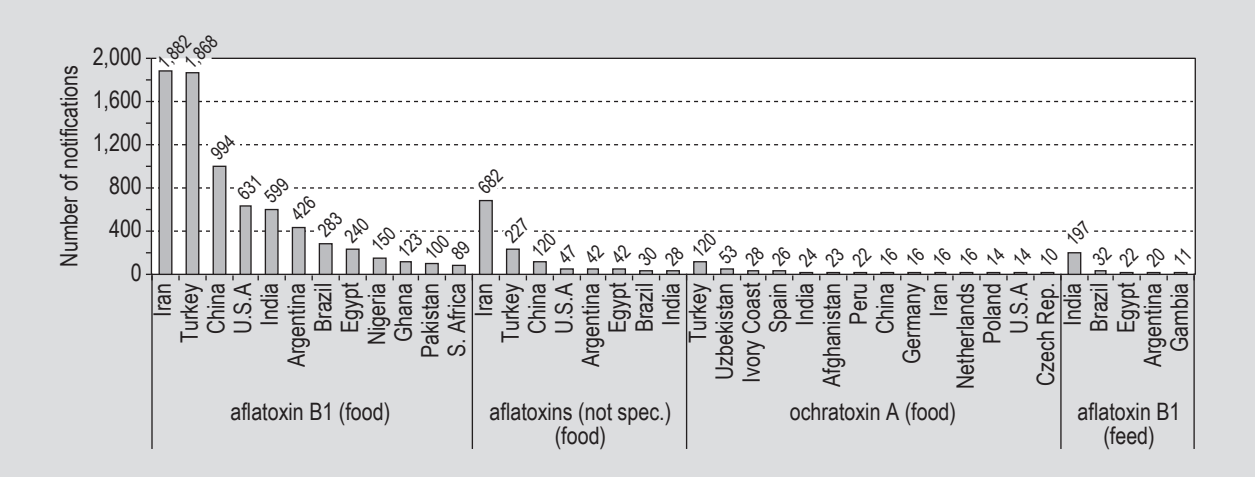

Figure 4. Number of RASFF notifications on mycotoxins in food and feed according to the country of origin.

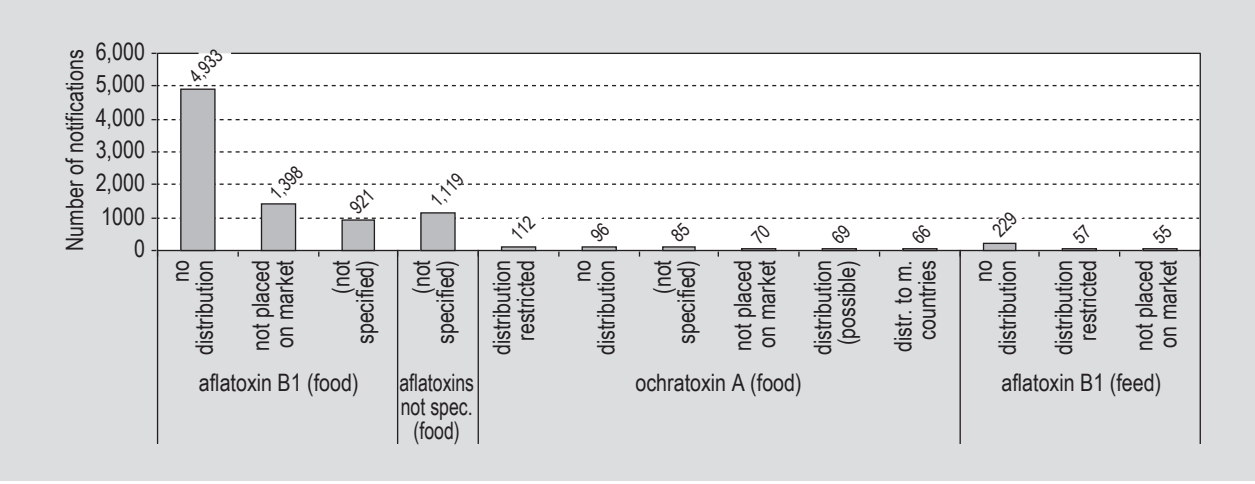

Figure 5. Number of RASFF notifications on mycotoxins in food and feed according to the distribution status.

case of all the discussed mycotoxins was most frequently not made. The products containing AFB_1 and aflatoxins (not specified) were mostly re-dispatched, while products with OTA were withdrawn from the market or also re-dispatched (European Commission, 2018c).

The notifications on mycotoxins (mainly AFB_1) were also related to feed. A significant increase in the notification number occurred after 2009, when Regulation 669/2009 on official controls on imports of certain feed and food of non-animal origin was introduced (European Commission, 2009). The highest number of notifications on AFB_1 in feed occurred in 2011 and then decreased (Figure S6). The notifications on this mycotoxin were related mainly to feed materials and pet food (Figure 2 and Figure S7). In feed AFB_1 was reported mostly by the United Kingdom and also by Belgium and the Netherlands (Figure 3 and Figure S8), and it concerned products originating mainly from India (Figure 4 and Figure S9). The notification basis of this mycotoxin was border control, after which the consignment was detained; therefore the notification type was border rejection. The products were mostly not distributed (Figure 5 and Figure S10), distribution was restricted to the notifying country or the product was not (yet) placed on the market. The risk decision was usually not made and the products were officially detained, re-dispatched or destroyed (European Commission, 2018c).

4. Discussion

RASFF notifications on mycotoxins in other studies

The notifications on mycotoxins in the RASFF have been reported by many authors, who often pointed out that this was the most frequently notified hazard category. They referred to particular years, i.e.: notifications from 2002 (McEvoy, 2015), in 2003-2007 (Kleter *et al.*, 2009), in 2005 (Van Egmond *et al.*, 2007), in 2006 (Tedesco *et al.*, 2008), in 2007-2009 (Rortais *et al.*, 2010), in 2008 (Cheftel, 2011; Giorgi and Lindner, 2009), in the years before 2009 (Spichtinger and Astley, 2009), in 2011 (Cheli *et al.*, 2014; Gil-Serna *et al.*, 2015), in 2015 (Ismail and Nielsen, 2017; Pose-Juan *et al.*, 2016) and in the decade before 2016 (García-Fonseca *et al.*, 2016). Some of the authors indicated mycotoxin type reported in the RASFF, i.e.: aflatoxins and OTA in 2002-2008 (Pereira *et al.*, 2014), aflatoxins in 2004-2006 (Oreopoulou *et al.*, 2009), aflatoxins in 2008-2010 (Petróczi *at al.* 2011), aflatoxins in 2009 (Majeed *et al.*, 2013) and aflatoxins in 2013 (Aldars-García *et al.*, 2015).

In the RASFF 2015 annual report, aflatoxins in nuts, nut products and seeds from China, Iran, Turkey and the United States (reported mainly by the Netherlands, Germany, Italy) and in fruits and vegetables from Turkey were notified among the most reported hazards (EU, 2016). The most frequent notifications were on aflatoxins in: nuts from Iran, China and Turkey in 2014 (Aldars-García *et al.*, 2016); pistachio nuts from Iran in 2005 (Ariño *et al.*, 2009; Molyneux *et al.*, 2007); dried chestnuts from Italy in 2010-2012 (Bertuzzi *et al.*, 2015); nuts from the USA and Australia in 2012 and 2013 (Gallo *et al.*, 2016); pistachios from Iran and Turkey and groundnuts from China, Argentina, Egypt, India, the USA and South Africa in 2002-2012 (Hepsag *et al.*, 2014); nuts from Turkey in 2009 and in 2002-2014 (Kabak, 2012, 2016); nuts from Iran in 2003-2007 (Kleter *et al.*, 2009); dried chestnuts from Italy in 2010 and 2011 (Pietri *et al.*, 2012); peanuts from Argentina, China, the USA, Brazil, Egypt and South Africa, pistachio nuts from Iran, Turkey and the USA, hazelnuts from Turkey, almonds from the USA in 2009 (Rodrigues *et al.*, 2012); pistachio nuts from Iran in 2002-2004 (Wesolek and Roudot, 2016) and nuts from Iran in 2000-2004 (Wiig and Kolstad, 2005). Notifications of aflatoxins in nuts in the RASFF were also mentioned by Clavel and Brabet (2013), Cunha *et al.* (2018), Duarte *et al.* (2010), Freitas-Silva and Venâncio (2011), Fusco *et al.* (2015), Georgiadou *et al.*

(2012, 2015), Johannessen and Cudjoe (2014), Marín *et al.* (2012, 2013), Uyttendaele *et al.* (2014), Van de Perre *et al.* (2015), Van Egmond *et al.* (2007) and Wang *et al.* (2018). Apart from aflatoxins in nuts, García-Cela *et al.* (2012, 2013) noted notifications also on OTA.

The notifications of mycotoxins in nuts from Iran drew the attention of the European Commission, which issued Decision 2005/85/EC imposing special conditions on the import of pistachios and certain products derived from pistachios originating in or consigned from Iran (European Commission, 2005). After several more changes, Regulation 884/2014 imposing special conditions governing the import of certain feed and food from certain third countries due to a contamination risk by aflatoxins is now in force (European Commission, 2014). Cheraghali and Yazdanpanah (2010) noted a decrease of notifications of aflatoxins in pistachio nuts from Iran in 2005-2007, while the import remained at the same level. However, Imperato *et al.* (2011) noted an increase of notifications of aflatoxins in nuts from Turkey in 2004-2008. Petróczi *et al.* (2011) pointed out that contents of mycotoxins in products from Iran in RASFF notifications decreased in 2008-2010 in contrast to Turkey and China. Dini *et al.* (2013) also mentioned aflatoxins in nuts from Iran in 2005-2011 and noted a decrease in the notification number after 2008. This decrease was also mentioned by Freitas-Silva and Venâncio (2011), Hepsag *et al.* (2014) and Pereira *et al.* (2014). Alldrick *et al.* (2009b) drew attention to the fact that the notifications on mycotoxins in the RASFF were related to border controls. Köppen *et al.* (2010) noted that border rejections on mycotoxins (mainly aflatoxins) may cause significant economic losses for producers, traders and the processing industry. However, border rejections due to mycotoxins in the last years were also noted by Brera *et al.* (2014), Marín *et al.* (2013), Picot *et al.* (2017), Pigłowski (2017) and Van de Perre *et al.* (2015).

Fruits and vegetables were also often reported in the RASFF. These notifications concerned particularly aflatoxins in dried figs from Turkey in 2003-2007 (Bircan, 2009), in 2004-2008 (Imperato *et al.*, 2011) and in 2002-2014 (Kabak, 2016). However, notifications of mycotoxins in fruits and vegetables in the RASFF were also reported by Brandão *et al.* (2015), Fusco *et al.* (2015), Johannessen and Cudjoe (2014), Kirezieva *et al.* (2015), Kleter *et al.* (2009), Marín *et al.* (2013), Rodrigues *et al.* (2012), Uyttendaele *et al.* (2014), Van Boxstael *et al.* (2013), Van de Perre *et al.* (2015), Van Egmond *et al.* (2007) and Wang *et al.* (2018).

In turn, notifications of mycotoxins in herbs and spices were reported by Golge *et al.* (2013) (aflatoxins in chilli from India and paprika from Spain, Turkey and Peru in 2002-2012), Ozbey and Kabak (2012) (aflatoxins and OTA in capsicums from China in 2011) and Zhao *et al.* (2014) (paprika, chilli and pepper from Peru, India, Spain and China in 2001-2014). The notifications of aflatoxins in herbs and spices in the RASFF were also mentioned by Banach *et al.* (2016), Bouzembrak *et al.* (2018), Caballero-Casero *et al.* (2018), Johannessen and Cudjoe (2014), Kleter *et al.* (2009), Marín *et al.* (2013), Rodrigues *et al.* (2012), Uyttendaele *et al.* (2014), Van Boxstael *et al.* (2013) and Van de Perre *et al.* (2015).

Mycotoxins reported in cereals and bakery products within the RASFF are as follows: aflatoxins in flours and flakes from Italy in 2010-2012 (Bertuzzi *et al.*, 2015); aflatoxins, OTA, deoxynivalenol and fumonisins in products from Europe in 2011 and 2012 (Oliveira *et al.*, 2014); aflatoxins in flours and flakes from Italy in 2010 and 2011 (Pietri *et al.*, 2012) and aflatoxins in rice from Pakistan and India in 2008 (Reiter *et al.*, 2010). The notifications of mycotoxins in cereals and bakery products in the RASFF were also reported by Alldrick (2017), Cheli *et al.* (2014), Duarte *et al.* (2010), Kabak (2012), Kleter *et al.* (2009), Marín *et al.* (2013), Rodrigues *et al.* (2012) and Van Egmond *et al.* (2007). In turn, notifications of OTA in coffee were reported by Gil-Serna *et al.* (2014), Kleter *et al.* (2009) and Van Egmond *et al.* (2007).

Moreover, the notifications on mycotoxins in feed in the RASFF were reported by Arroyo-Manzanares *et al.* (2015), Bouxin (2014), Cheli *et al.* (2014) and Rodrigues *et al.* (2012). Gazotti *et al.* (2015) mentioned border rejections due to the occurrence of aflatoxins in vegetable raw materials of pet food imported from non-EU countries.

Mycotoxins in reports of other institutions

Problems with mycotoxins in food are also reported by other international institutions. However, the Food and Veterinary Office (FVO), which operated within the European Union, does not maintain a database on food controls/audits. The data included in the annual reports of the FVO (issued only in 1998-2013) are general, while the detailed data are given in separate reports (European Commission, 2018a).

In the last available activity report (2014/2015) of the International Food Safety Authorities Network (INFOSAN), operating within the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organisation (WHO), events related to aflatoxins in 2012 and 2013 were reported (FAO/WHO, 2016). The database of the Global Environment Monitoring System – Food Contamination Monitoring and Assessment Programme (GEMS/Food) of WHO covers 842,954 records on mycotoxins from 1990 to 2017. The highest number of records in the GEMS/Food database are related to AFB_1 (149,395; 18%), followed by aflatoxin B2 (119,027; 14%), aflatoxin G2 (118,966; 14%) and aflatoxin G1 (118,915; 14%). The records are also related to aflatoxin M1, deoxynivalenol, fumonisin B1, fumonisin B2, fumonisin B3, fumonisins

(total), OTA, patulin, T-2 and zearalenone (WHO, 2018). In the last years the GEMS/Food also focused on aflatoxins – see the contour chart using two-way joining in Figure S11. The records are related mainly to aflatoxins in nuts, herbs, spices and cereals and also to deoxynivalenol, fumonisin B1 and zearalenone in cereals (Figure S12). The products originated mainly from the WHO European Region, particularly from Germany (Figure S13). The food state was usually unknown (Figure S14).

Reduction of the hazards of mycotoxins

Tirado *et al.* (2010) noted that complete prevention of contamination with mycotoxins is not feasible because their occurrence is a natural consequence of interactions between plants and fungi. Therefore, the aim should be prevention of mycotoxin levels that might be harmful. In order to obtain the maximum effect, the aetiology of toxin contamination must be known. They also proposed monitoring and predictive modelling, maintenance of strategic food stocks, conducting the proper agricultural policy, informing the public and imposing limits on mycotoxin contents in commodities.

Gelderblom *et al.* (2014) proposed control measures to reduce mycotoxins in nuts, e.g. proper sanitation in nut trees, stacking of proper windrows at harvest, storage of products in dry, ventilated and temperature-controlled conditions, separating good and mouldy lots, regular inspection of equipment and rapid processing, and drying and packaging of foodstuffs. Khan *et al.* (2017) pointed out that ozone treatment inhibits fungal activity and allows control of mycotoxin contamination in peanuts. Additionally, to reduce mycotoxin contamination in feed, the following actions can be taken: planting adapted varieties, proper fertilisation, weed control, necessary irrigation and proper crop rotation (Binder, 2007).

Remarks related to data on mycotoxins from the RASFF database

The data related to mycotoxin type, product category and country of origin can be helpful for the European and national authorities in planning food audits/controls (on the internal market and border posts) and changes of law. Due to the fact that most notifications apply to imported products, EU authorities and also scientific institutions can create more detailed programmes of cooperation with third countries in the area of the agricultural policy (e.g. plant protection products, irrigation, new varieties) and transport. Unfortunately, in the case of mycotoxin type, notification basis, distribution status, risk decision and action taken, the RASFF data were often inaccurate, ambiguous or incorrect, and the notification type was changed. This data should be, therefore, completed or updated by reporting countries to enable a more detailed analysis. Additionally, the data on country of origin should be divided into the country of origin of raw materials, the country of production and the countries where the product was distributed. The name of the economic operator and a photograph of the reported product added to the RASFF database could help in traceability of the product.

5. Conclusions

Mycotoxins were the most frequently reported hazard in the RASFF in 1981-2017 (21% of all notifications). These notifications related mainly to food (96%) and only 4% to feed. The majority of notifications concerned AFB_1 (80%), followed by aflatoxins (not specified) (13%) and OTA (5%). The number of notifications increased in 2004-2005 (after introducing controls to the market) and decreased after 2008 (after introducing border rejections) and increased in recent years again. The most frequently reported products were nuts, fruits, vegetables and herbs and spices. The products were reported mainly by Germany, the Netherlands, the United Kingdom and Italy and originated from Iran, Turkey and China. The notification basis was border control after which the products were detained (border rejections) or controls on the market resulting in alert or information notifications. The reported products were not distributed, products were not placed on the market or distribution status was not specified. The risk decision was usually not made. The reported products were re-dispatched, import was not authorised or products were officially detained.

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Supplementary material

Supplementary material can be found online at https://doi.org/10.3920/QAS2018.1398

Figure S1. Comparison of RASFF notifications on mycotoxins and notification year for food.

Figure S2. Comparison of RASFF notifications on mycotoxins and product category for food.

Figure S3. Comparison of RASFF notifications on mycotoxins and notifying country for food.

Figure S4. Comparison of RASFF notifications on mycotoxins and country of origin for food.

Figure S5. Comparison of RASFF notifications on mycotoxins and distribution status for food.

Figure S6. Comparison of RASFF notifications on mycotoxins and notification year for feed.

Figure S7. Comparison of RASFF notifications on mycotoxins and product category for feed.

Figure S8. Comparison of RASFF notifications on mycotoxins and notifying country for feed.

Figure S9. Comparison of RASFF notifications on mycotoxins and country of origin for feed.

Figure S10. Comparison of RASFF notifications on mycotoxins and distribution status for feed.

Figure S11. Comparison of GEMS/Food records on mycotoxins and notification year.

Figure S12. Comparison of GEMS/Food records on mycotoxins and product category.

Figure S13. Comparison of GEMS/Food records on mycotoxins and country of origin.

Figure S14. Comparison of GEMS/Food records on mycotoxins and food state.

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