

Analysis of RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019

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Analysis of RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019

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Abstract

The Rapid Alert System for Food and Feed (RASFF) is designed to respond promptly to the health risks associated with food, food contact materials or feed by enabling fast exchange of information between bodies and institutions involved in the system. Mycotoxins, secondary metabolites produced by moulds, are common contaminants found in cereals and cereal-based product all over the world that can be harmful to human (and animal) health. The aim of this study was to analyse RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019. All data were downloaded from the RASFF database (RASFF portal) and processed in MS Excel 2010. The collected data provided information on the: notifying country, country(ies) of origin and distribution of the contaminated product, notification basis, notification type, risk decision, distribution status, action taken, type of mycotoxin and specific cereal or cereal-based product in which the mycotoxin has been determined. Nearly half of the reported food products originated from Italy, Pakistan, India, Serbia and Sri Lanka. More than half notifications were published by Germany, Switzerland, Italy and Belgium. Only in less than one-fifth of the notifications the country of origin of the contaminated product was also the notifying country. Contaminated products in more than two-thirds of cases were maize, rice and rye grains and their products. Aflatoxin B1 was the most frequent mycotoxin, present in more than two-fifths of contaminated cereals and cereal-based products. The majority of the notifications were classified as alert notifications and a large majority of total number of notifications were of serious risk. Regarding

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⁶ Friganović, E., Nimak, A., Sečan, A., Dorbić, B., Matin, A., Ćurić, D., Krička, T. (2022). Analysis of RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019. *Glasilo Future*, 5(5-6), 15–36.

the distribution status, over two-fifths of contaminated products were distributed to other member countries and in almost half of the notifications contaminated products were withdrawn or recalled.

Key words: RASFF, notifications, cereals and cereal-based products, mycotoxins.

Introduction

The Rapid Alert System for Food and Feed (RASFF), run by the European Commission, is designed to respond promptly to the health risks associated with food, food contact materials or feed by enabling fast exchange of information between bodies and institutions involved in the system which in case of health risk initiate an immediate notification procedure (EC, 2020a; EC 2020b). Mycotoxins are secondary metabolites produced by moulds and are common contaminants of food and feed, found in cereals all over the world (Peraica et al. 2002; Pleadin et al., 2017). The production of mycotoxins is greatly influenced by environmental factors and physical and chemical properties of cereals too (Delaš, 2010; Cvjetković, 2014). The most significant mycotoxin producing moulds, especially on cereals, are species from the genera *Penicillium*, *Aspergillus* and *Fusarium* (Jašić, 2009; Cvjetković, 2014). Mycotoxins like aflatoxins, ochratoxin A, trichothecenes type A and B, fumonisins, zearalenone, ergot alkaloids and *Alternaria* toxins are commonly detected in cereal grains and their high levels have been reported in cereal grains and cereal-based products (van den Brand and Bulder, 2020). Mycotoxins can accumulate in the body through a longer period of consumption of lower concentrations of mycotoxin-contaminated food, or can be ingested with a single meal with a higher concentration of mycotoxins, both resulting in mycotoxicosis, chronic or acute, respectively. Mycotoxins can have cytotoxic, carcinogenic, mutagenic, genotoxic, teratogenic, immunotoxic, hematotoxic, hepatotoxic, nephrotoxic and dermatotoxic effects to humans and animals (Jašić, 2009; Delaš, 2010). Aflatoxins are produced by some moulds of the genus *Aspergillus*, *Penicillium* and *Fusarium* (Delaš, 2010). They represent a group of 20 related compounds, among which the most significant representatives are aflatoxins B1, B2, G1, G2, M1 and M2, of which aflatoxin B1 is a contaminant of various foods, very potent toxin, carcinogenic and genotoxic substance, and there is no actual safe level of intake (Peraica and Rašić, 2012; EC, 2020b). Ochratoxin A is produced by fungi of the genus *Aspergillus* and *Penicillium* and found as a contaminant in various foods. It is a not confirmed genotoxic carcinogen (EC, 2017) but is classified as "possibly carcinogenic to humans" and highly harmful to human health. *Fusarium* mould growth is typically linked to cereal products. The toxins produced are known as fumonisins, a group of 15 compounds of which three are the most common: fumonisins, B1, B2 and B3. The legal limits for these toxins are much higher than those for other mycotoxins because of their relatively lower toxicity (Delaš, 2010; EC, 2017). Type A trichothecene mycotoxins, such as T-2 toxin and its main metabolite HT-2 toxin, are produced by *Fusarium* moulds and are primarily found in cereals and cereal-based products and are commonly more toxic than type B trichothecenes, such as deoxynivalenol (DON) (Pleadin et al., 2017; Arcella et

al., 2017). Zearalenone is mycotoxin produced by several species of *Fusarium* moulds. It has significant effects on female reproduction, causing hyperestrogenism, but it also has an impact on the male reproductive system. Zearalenone is classified in IARC group⁷ 3 but recent reports indicate that it poses a serious threat to human health (Gupta et al., 2018). Preventing the growth of moulds as well as the formation of mycotoxins can be achieved by applying a series of measures of good agricultural practice and good production practice (pre-harvest, harvest and post-harvest measures) (Delaš, 2010; Cvjetković, 2014). Physical and chemical methods of food and feed decontamination could be applied as well as processing that might have a different effect on the degradation, transformation, and modification of mycotoxins (Peraica et al. 2002; Sarmast et al., 2021). All decontamination techniques of food and feed, which are far from ideal due to possible occurrence of mycotoxin residues and metabolites as well as food and feed degradation, raise production costs and ought to only be used when preventive agro-technical measures, crucial for crop protection against contamination by mycotoxins, have failed (Peraica et al. 2002). According to European Commission (EC, 2016; EC, 2017; EC, 2019b; EC, 2020b) mycotoxins are the most reported type of hazard for products from non-member countries. Only for the year 2017 the number of notifications on pathogenic micro-organisms in food from non-member countries was higher than the number on mycotoxin contamination reported cases (EC, 2019a). The aim of this study was to analyse RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019.

Materials and methods

All data on notifications for the presence of mycotoxins in cereals and cereal-based products were downloaded from the RASFF portal database (EC, 2020c) and processed in MS Excel 2010 (univariate descriptive statistics) (Microsoft Corporation). The search criteria were as follows: "Product type: food", "Hazard category: mycotoxins", "Notified from: 01/01/2015", "Notified till: 31/12/2019" and "Product category: Cereals and bakery products". The collected data provided information on the: notifying country, country(ies) of origin and distribution of the contaminated product, notification basis, notification type, risk decision, distribution status, action taken, type of mycotoxin and specific cereal or cereal-based product in which the mycotoxin has been determined.

Results and discussion

In the period from 01/01/2015 to 31/12/2019 a total of 132 RASFF notifications were published on cereals and cereal-based products contaminated with mycotoxins. Germany was notifying country in 16.7 % of the published notifications, followed by Switzerland (15.9 %), Italy (11.4 %) and Belgium

⁷ International Agency for Research on Cancer: Group 1: carcinogenic; Group 2A: probably carcinogenic; Group 2B: possibly carcinogenic; Group 3: not classifiable; Group 4: probably not carcinogenic.

(9.1 %) what makes them notifying countries in more than half (53.1 %) of cases. Other countries that participated as notifying countries in more than 5% of published notifications each were Luxembourg (7.6 %), Slovenia (6.8 %) and France (5.3 %) (Table 1.). Contaminated products in question originated in 16 RASFF member countries and 16 RASFF non-member countries. The country of origin of cereals and cereal-based products contaminated with mycotoxins in 15.2 % of notifications was Italy, then Pakistan, India, Serbia and Sri Lanka in 9.1 %, 8.3 %, 8.3 % and 7.6 % of notifications, respectively. Only in 18.9 % of total notifications the country of origin of the contaminated product was also the notifying country. If we observe the same only for RASFF member countries, the result is better, 36.2 %, but still indicative suggesting that public health threats were not recognized in the shortest timeframe possible. In 8.3 % of cases two countries were countries of origin of the contaminated product and in 1.5 % of cases three countries were countries of origin. In 1.5 % of cases the county of origin of contaminated product was not determined (Table 2.).

Table 1. RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019 by year and notifying country.

| Notifying country | Year and number of notifications | | | | | Total | | |
|--------------------|----------------------------------|------|------|------|------|-------|------|-----|
| | 2015 | 2016 | 2017 | 2018 | 2019 | No. | % | |
| 1. Austria | 0 | 1 | 0 | 0 | 1 | 2 | 1.5 | |
| 2. Belgium | 5 | 0 | 2 | 2 | 3 | 12 | 9.1 | |
| 3. Croatia | 2 | 0 | 0 | 1 | 1 | 4 | 3.0 | |
| 4. Czech Republic | 0 | 0 | 1 | 0 | 0 | 1 | 0.8 | |
| 5. Denmark | 0 | 0 | 2 | 0 | 1 | 3 | 2.3 | |
| 6. Finland | 1 | 1 | 0 | 2 | 0 | 4 | 3.0 | |
| 7. France | 3 | 0 | 2 | 0 | 2 | 7 | 5.3 | |
| 8. Germany | 3 | 6 | 2 | 7 | 4 | 22 | 16.7 | |
| 9. Hungary | 0 | 1 | 0 | 2 | 2 | 5 | 3.8 | |
| 10. Ireland | 0 | 0 | 1 | 0 | 0 | 1 | 0.8 | |
| 11. Italy | 4 | 3 | 3 | 2 | 3 | 15 | 11.4 | |
| 12. Luxembourg | 4 | 5 | 0 | 0 | 1 | 10 | 7.6 | |
| 13. Malta | 1 | 0 | 0 | 0 | 0 | 1 | 0.8 | |
| 14. Netherlands | 0 | 1 | 0 | 0 | 0 | 1 | 0.8 | |
| 15. Poland | 1 | 0 | 1 | 3 | 4 | 9 | 6.8 | |
| 16. Portugal | 0 | 0 | 0 | 0 | 1 | 1 | 0.8 | |
| 17. Slovakia | 1 | 0 | 0 | 0 | 0 | 1 | 0.8 | |
| 18. Slovenia | 2 | 3 | 2 | 0 | 2 | 9 | 6.8 | |
| 19. Spain | 0 | 0 | 0 | 1 | 0 | 1 | 0.8 | |
| 20. Sweden | 0 | 1 | 0 | 0 | 0 | 1 | 0.8 | |
| 21. Switzerland | 3 | 3 | 6 | 7 | 2 | 21 | 15.9 | |
| 22. United Kingdom | 1 | 0 | 0 | 0 | 0 | 1 | 0.8 | |
| Total | No. | 31 | 25 | 22 | 27 | 27 | 132 | 100 |
| | % | 23.5 | 18.9 | 16.7 | 20.5 | 20.5 | 100 | |

Table 2. Countries of origin of cereals and cereal-based products contaminated with mycotoxins in RASFF notifications in the period from 01/01/2015 to 31/12/2019 (% of cases).

| Country of origin | % of cases |
|------------------------------|------------|
| 1. Argentina | 0.8 |
| 2. Austria | 0.8 |
| 3. Belgium | 4.5 |
| 4. Bosnia and Herzegovina | 0.8 |
| 5. Canada | 1.5 |
| 6. Czech Republic | 6.1 |
| 7. Ethiopia | 0.8 |
| 8. France | 5.3 |
| 9. Germany | 6.1 |
| 10. Ghana | 2.3 |
| 11. Greece | 0.8 |
| 12. Hungary | 2.3 |
| 13. India | 8.3 |
| 14. Italy | 15.2 |
| 15. Kosovo | 0.8 |
| 16. Lithuania | 0.8 |
| 17. Myanmar | 1.5 |
| 18. Netherlands | 1.5 |
| 19. Pakistan | 9.1 |
| 20. Poland | 5.3 |
| 21. Portugal | 4.5 |
| 22. Romania | 0.8 |
| 23. Russia | 0.8 |
| 24. Serbia | 8.3 |
| 25. Sri Lanka | 7.6 |
| 26. Sweden | 0.8 |
| 27. Switzerland | 2.3 |
| 28. Syria | 0.8 |
| 29. Thailand | 0.8 |
| 30. Turkey | 2.3 |
| 31. United Kingdom | 3.0 |
| 32. United States of America | 2.3 |
| 33. Unknown origin | 1.5 |

RASFF notifications on the presence of mycotoxins in cereals and cereal-based products in the period from 01/01/2015 to 31/12/2019 mostly referred to maize and maize-based products (31.1 %), rice and rice-based products (30.3 %), then rye and rye-based products (8.3 %), wheat and wheat-based products (7.6 %), oat and oat-based products (4.5 %), buckwheat and buckwheat-based products (3.8 %), barley and barley-based products (2.3 %) and millet flour (0.8 %). In the remaining cases of contaminated cereal-based products the exact cereal was not specified (RASFF Portal, 2020). Aflatoxin B1 was the most frequent mycotoxin, present in 43.2 % of cases of contaminated cereals and cereal-based products, followed by ochratoxin A (28.8 % of cases), deoxynivalenol (DON) (18.9 % of cases), fumonisins (12.1 % of cases), zearalenone (3.8 % of cases) and T-2 with HT-2 toxin (3.8 % of cases). In addition to the already mentioned T-2 toxin and its metabolite HT-2 toxin, in ten more cases

food products were contaminated with two mycotoxins (aflatoxin B1 + ochratoxin A; aflatoxin B1 + fumonisins; DON + ochratoxin A; DON + fumonisins; DON + zearalenone) (Table 3.).

Table 3. Mycotoxins present in cereals and cereal-based products according to RASFF notifications in the period from 01/01/2015 to 31/12/2019 (% of cases).

| Mycotoxin | % of cases | | |
|-------------------------|------------|---|------|
| | Total | In specific cereal or cereal-based products | |
| 1. Aflatoxin B1 | 43.2 | Rice and rice-based products | 26.5 |
| | | Maize and maize-based products | 11.4 |
| | | Biscuits and pastry | 2.3 |
| | | Wheat-based products | 0.8 |
| | | Millet flour | 0.8 |
| | | Barley | 0.8 |
| | | Muesli | 0.8 |
| 2. Ochratoxin A | 28.8 | Rye and rye-based products | 8.3 |
| | | Rice and rice-based products | 4.5 |
| | | Buckwheat and buckwheat-based products | 3.8 |
| | | Wheat and wheat-based products | 3.8 |
| | | Maize and maize-based products | 1.5 |
| | | Barley-based products | 1.5 |
| | | Oat and oat-based products | 1.5 |
| | | Breakfast cereals | 1.5 |
| | | Porridge | 1.5 |
| | | Bread crumbs | 0.8 |
| 3. Deoxynivalenol (DON) | 18.9 | Maize and maize-based products | 9.8 |
| | | Wheat and wheat-based products | 5.3 |
| | | Oat and oat-based products | 1.5 |
| | | Breakfast cereals | 1.5 |
| | | Bread crumbs | 0.8 |
| 4. Fumonisins | 12.1 | Maize and maize-based products | 12.1 |
| 5. Zearalenone | 3.8 | Maize-based products | 3.0 |
| | | Oat muesli | 0.8 |
| 6. T-2 and HT-2 toxin | 0.8 | Oat flour | 0.8 |

The majority of RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019 were classified as alert notifications (59.1 %) and 90.2 % of total number of notifications were of serious risk. Nearly half of the mycotoxin notifications were based on official controls on the market (46.2 %), 29.5 % were based on border control and 23.5 % were based on company's own check. Regarding the distribution status, 43.2 % of contaminated products were distributed to other member countries and in 47.0 % of the notifications contaminated products were withdrawn or recalled (Table 4.).

Table 4. RASFF notifications on cereals and cereal-based products contaminated with mycotoxins in the period from 01/01/2015 to 31/12/2019 by notification type, risk decision, notification basis, distribution status and action taken.

| Notification type / Total | Risk decision/ Total | Notification basis/ Total | Distribution status and Action taken | |
|--|-----------------------------|---|--|---|
| Alert notification (78; 59.1 %) | Serious (75) | Official control on the market (41) | Distribution restricted to notifying country (7) No distribution from notifying country (4) Distribution to other member countries (30) | |
| | | | Destruction (1) Detained by operator (2) Informing recipient(s) (2) Official detention (1) Public warning - press release (1) Re-dispatch (2) Return to consignor (2) Recall from consumers (19) Withdrawal from recipient(s) (1) Withdrawal from the market (10) | |
| | | | Company's own check (27) | Distribution restricted to notifying country (8) Distribution to other member countries (15) No distribution from notifying country (3) No distribution to notifying country (1) |
| | | | | Destruction (1) Detained by operator (3) Informing authorities (1) Informing recipient(s) (3) No action taken (1) Official detention (1) Recall from consumers (5) Re-dispatch (2) Return to consignor (1) Use in feed (1) Withdrawal from the market (7) ND (1) |
| | | | | Border control (7) |
| | | Informing consignor (1) Informing recipient(s) (1) No action taken (2) Official detention (1) Recall from consumers (1) Use for other purpose than food/feed (1) | | |
| | | Not Serious (0) | - | - |
| | | Undecided (3) | Official control on the market (2) | Distribution restricted to notifying country (1) No distribution from notifying country (1) Recall from customers (1) Return to consignor (1) |
| | | | | Company's own check (1) |
| | | Border rejection (26; 19.7 %) | Serious (24) | Border control (24) |

| Notification type / Total | Risk decision/ Total | Notification basis/ Total | Distribution status and Action taken |
|--|---|---|--|
| | | | Official detention (6) Physical/chemical treatment (1) Placed under customs seals (3) Re-dispatch (7) Return to consignor (2) |
| | Not serious (1) | Border control (1) | Product allowed to travel to destination under customs seals (1) Placed under customs seals (1) |
| | Undecided (1) | Border control (1) | Product allowed to travel to destination under customs seals (1) Use for other purpose than food/feed (1) |
| Information notification for attention (21; 15.9 %) | Serious (20) | Official control on the market (13) | Distribution restricted to notifying country (10) Distribution to non-member countries (1) Product (presumably) no longer on the market (2) |
| | | | No stock left (1) Public warning - press release (1) Recall from consumers (5) Withdrawal from the market (4) ND (2) |
| | | Company's own check (2) | Distribution to non-member countries (1) Product (presumably) no longer on the market (1) Official detention (1) Public warning - press release (1) |
| | Border control (5) | Distribution restricted to notifying country (5) Official detention (1) Recall from consumers (3) Withdrawal from the market (1) | |
| | | Not Serious (0) | - |
| | Undecided (1) | Border control (1) | Distribution restricted to notifying country (1) Official detention (1) |
| Information notification for follow-up (7; 5.3 %) | Serious (0) | - | - |
| | Not Serious (1) | Consumer complaint (1) | Distribution to other member countries (1) No action taken (1) |
| | | | Undecided (6) |
| Company's own check (1) | Distribution restricted to notifying country (1) Recall from consumers (1) | | |
| Total | Total | Total | Total |
| Alert notification (59.1 %) | Serious (90.2 %) | Official control on the market (46.2 %) | Distribution restricted to notifying country (25.8 %) |
| Border rejection (19.7 %) | Not Serious (1.5 %) | Company's own check (23.5 %) | Distribution to non-member countries (2.3 %) |
| Information notification for attention (15.9 %) | Undecided (8.3 %) | Border control (29.5 %) | Distribution to other member countries (43.2 %) |
| | | | Informing recipients (0.8 %) |
| | | | No distribution from notifying country (6.8 %) |
| | | | No distribution to notifying country (0.8 %) |
| | | | Product (presumably) no longer on the market (2.3 %) |

| Notification type / Total | Risk decision / Total | Notification basis / Total | Distribution status and Action taken |
|---|------------------------------|-----------------------------------|---|
| Information notification for follow-up (5.3 %) | | Consumer complaint (0.8 %) | Product allowed to travel to destination under customs seals (4.5 %) Product not (yet) placed on the market (13.6 %) |
| | | | Total Destruction (5.3 %) Detained by operator (3.8 %) Import not authorised (0.8 %) Informing authorities (0.8 %) Informing consignor (0.8 %) Informing recipient(s) (5.3 %) No action taken (3.0 %) No stock left (0.8 %) Official detention (9.1 %) Physical/chemical treatment (0.8 %) Placed under customs seals (3.0 %) Public warning - press release (2.3 %) Recall from customers (26.5 %) Re-dispatch (8.3 %) Return to consignor (4.5 %) Use for other purpose than food/feed (1.5 %) Use in feed (0.8 %) Withdrawal from recipient(s) (0.8 %) Withdrawal from the market (19.7 %) ND (2.3 %) |

Note: ND = no data available;

Conclusion

In the period from 01/01/2015 to 31/12/2019 a total of 132 RASFF notifications were published on cereals and cereal-based products contaminated with mycotoxins. Nearly half of the reported food products originated from Italy (15.2 %), Pakistan (9.1 %), India (8.3 %), Serbia (8.3 %) and Sri Lanka (7.6 %). More than half notifications were published by Germany (16.7 %), Switzerland (15.9 %), Italy (11.4 %) and Belgium (9.1 %). Only in less than one-fifth of the notifications the country of origin of the contaminated product was also the notifying country suggesting that public health threats were not recognized in the shortest timeframe possible. Contaminated products in more than two-thirds of cases were maize and maize-based products (31.1 %), rice and rice-based products (30.3 %), and rye and rye-based products (8.3 %). Aflatoxin B1 was the most frequent mycotoxin, present in 43.2 % of cases of contaminated cereals and cereal-based products. The majority of the notifications were classified as alert notifications (59.1 %) and 90.2 % of total number of notifications were of serious risk. Nearly half of the mycotoxin notifications were based on official controls on the market (46.2 %). Regarding the distribution status, 43.2 % of contaminated products were distributed to other member countries, which is worrying, as well is the fact that contaminated products were virtually available to consumers. In 47.0 % of the notifications, contaminated products were

withdrawn or recalled. We will refer to the conclusion of Friganović et al. (2019) that the aforementioned does not cast doubt upon RASFF system's efficacy in responding rapidly to health threats, but highlights the need to strengthen the preventive role of the competent authorities and food business operators themselves.

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