

STUDY ON FOOD SAFETY THROUGH RASFF NOTIFICATIONS IN CASE OF CONTAMINATION WITH MYCOTOXINS

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Abstract

The study is an analysis of the incidence of biological hazards identified in food and feed based on information from the annual reports of the Rapid Alert System for Food and Feed (RASFF) for the period 2007-2014. In terms of methodology it was resorted to the analysis of data from the notifications sent by the countries in the European Economic Area (EEA) regarding mycotoxin contamination (Aflatoxins, Deoxynivalenol, Fumonsine, Ochratoxin A, Patulin, Zearalenone) using classical statistical methods. The results show a significant incidence of cases of contamination with mycotoxins (between which predominates aflatoxins) but also its reduction trend (about 50% in the period under study); this evolution can be considered to reflect the usefulness and efficiency functioning RASFF.

Key words: mycotoxins, aflatoxin notifications, food, feed

INTRODUCTION

The molds and mycotoxins produce by them lead not only to reduce the quantity and quality of crop yields damage, as well as the emergence of various diseases in animals and man, continuing to remain a major economic problem worldwide, for agriculture and also for the food industry [7, 4, 2]. Mycotoxins are naturally occurring metabolites produced by certain species of fungi (for example *Aspergillus spp.*, *Fusarium spp.*) which grow at high temperatures and humidity, and may be present in a large number of food products. This group of toxins includes a number of compounds with varying toxicity and frequency in food, and ingesting them can cause diseases in animals and humans. Mycotoxins such as aflatoxins and ochratoxin A are known to be carcinogenic, can cause liver, testicular or kidney cancer [6, 3, 1]. The overall incidence of mycotoxin contamination feed materials for feeding stuffs and severity of mycotoxin poisoning in animals seem to have increased in recent years; possible causes include: intensifying the process of monitoring

of suspicious materials and detection of mycotoxin poisoning symptoms by veterinarians and breeders, climate change, intensifying global trade etc [1]. National control authorities in the European Union, notify the Commission whenever it discovers a lot of fodder or food with mycotoxin levels over that maximum allowed. These notices are published on the Internet in the Rapid Alert System (RASFF) [8, 9, 10, 11, 12, 13, 14, 15]. Other control authorities, food factories and feed factories will be alerted by RASFF about lots of products that may contain mycotoxin levels above the permissible limit, thus preventing their entry into the food chain of the European Union [5].

MATERIAL AND METHOD

Methodological was recourse to comparing data referring notifications on mycotoxin contamination (Aflatoxin, Deoxynivalenol (DON), Fumonsine, Ochratoxin A, Patulin and Zearalenone) of food and feed, and the results were statistically interpreted through classic methods (arithmetic mean (\bar{X}), standard deviation (s), variance (S^2) and coefficient of variation (V%)), according to the incidence of contamination of the each year included in the study.

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RESULTS AND DISCUSSIONS

After analyzing data from the years 2007-2014 RASFF reports regarding mycotoxin contamination of food and feed it has been found that the aflatoxins hold first place as

number of notifications (4600 from the total of 5006 for the 8 years analyzed), followed by Ochratoxin A (289), DON (52) and fumonisins (39). The fewer notifications (fig.1, tab. 1) were recorded for zearalenone (17) and patulin (9).

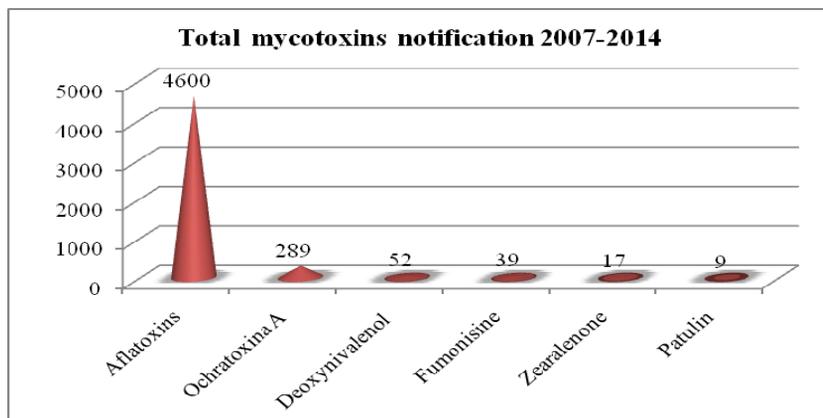


Fig. 1 Total RASFF notifications regarding the type of mycotoxins in food and feed for the period 2007-2014

Following analysis of notifications for the eight years studied, is observed downward trend of mycotoxin contamination in food and feed (Table. 1). Thus, in 2014 have been

recorded by about 50% less notices than in 2009 (this being the year with the most notifications, respectively 933 of which 902 for aflatoxins).

Table 1 Total notifications relating to mycotoxins in food and feed for the period 2007-2014

Mycotoxins	Years							
	2007	2008	2009	2010	2011	2012	2013	2014
Aflatoxins	705	902	638	649	585	484	341	296
Deoxynivalenol DON	10	4	3	2	11	4	8	10
Fumonisine	9	2	1	3	4	4	7	9
Ochratoxina A	30	20	27	34	35	32	54	57
Patulin	0	3	0	0	0	0	0	6
Zearalenone	6	2	0	0	0	4	0	5
Total mycotoxins	766	933	669	688	635	528	410	383

Following the classical statistical calculations (tab. 2), there is an average value of 626.50 notification for the years included in the study (2007-2014), most of which (575.0±69.98) are for aflatoxins [8, 9, 10, 11, 12, 13, 14, 15]; these are followed by much lower values for ochratoxin A (36.13±4.55),

DON (6.50±1.28), fumonisins (4.88±1.09), zearalenone 2.13±0.90 and the lowest value for patulin (1.13±0.79). The coefficient of variation (V%) exceeded the threshold of 20%, expressing values inhomogeneous for the data analyzed.

Table 2 Mycotoxin contamination of feed and food for the years 2007-2014

Total of mycotoxins	$\bar{X} \pm S \bar{x}$	S ²	S	V%	\bar{X}_{\min}	\bar{X}_{\max}
Aflatoxins	575.00±69.98	398.86	197.94	34.42	296.00	902.00
Deoxynivalenol DON	6.50±1.28	13.14	3.63	55.77	2.00	11.00
Fumonisine	4.88±1.09	9.55	3.09	63.40	1.00	9.00
Ochratoxina A	36.13±4.55	165.55	12.87	35.62	20.00	57.00
Patulin	1.13±0.79	4.98	2.23	198.41	0.00	6.00
Zearalenone	2.13±0.90	6.41	2.53	119.15	0.00	6.00
Total mycotoxins	625.75±64.54	326.79	182.56	29.17	383.00	933.00

Further were analyzed the information from RASFF reports during those eight years under study (from 2007 to 2014) covering the main categories of food and feed, specifying the each provenance and incidence of contamination for every type of mycotoxin in part.

In 2007, RASFF received a total of 754 notifications relating to mycotoxins, of which 705 concerning of aflatoxins [8]. The majority of complaints relating to pistachios (176) were for those coming from Iran (126). Be noted is the relatively high number of notifications relating to aflatoxins in pistachios presence of Turkey (33) compared to the quantities imported; this is reflected by the high number nonconformance's identified on imports (25% of imported consignments were rejected because of high aflatoxins content). Other

notifications aimed pistachios in Lebanon (6), United States (5) and Syria (3). Aflatoxins are frequent in peanuts and derived products (163 notifications) -originating from different countries: China (54), Argentina (20) USA (15), Egypt (13), Nicaragua (9), India (7) Ghana (6), Brazil (5) and Nigeria (5). In the group of nuts and derived products have been registered 105 notifications, almost all originating from Turkey (103). As regards almonds and derived products have been recorded 76 notifications, of which 68 originating from the US. It was recorded only a notification regarding aflatoxins in Brazilian walnut kernel and one on Brazilian nuts in shell originating from Brazil (although EU legislation condition testing on importation Brazil nuts in shell).

Table 3 Mycotoxin contamination of nuts, seeds and derived products for the years 2007-2014

Nuts, seeds and derived products	$\bar{X} \pm S \bar{X}$	S ²	S	V%	\bar{X}_{max}
Aflatoxins	313.50±92.60	682.86	261.92	83.55	710.0
Deoxynivalenol DON	0.63±0.42	1.41	1.19	190.04	3.0
Fumonisine	0.38±0.18	0.27	0.52	138.01	1.0
Ochratoxina A	0.25±0.5	0.50	0.71	282.84	2.0
Patulin	0.75±0.16	0.21	0.46	61.72	1.0
Zearalenone	0.13±0.3	0.3	0.35	282.84	1.0

As an, the average more notifications of mycotoxins in nuts category, derivatives and seeds were recorded for aflatoxins (331.5 notifications). The coefficient of variation reported by RASFF expressed heterogeneity of values for this category of products (tab. 3).

In the group of fruits and vegetables, in 2007, 63 notifications have targeted dried figs

and derived products originating mainly from Turkey (59). Also, there were 17 notifications (all from UK) on melon seeds originating from Nigeria. The highest incidence of contamination for this product category was observed also for aflatoxins (61.50±16.80), followed by the one for ochratoxin A (10.25±3.54) (tab. 4).

Table 4 Contamination with mycotoxins of fruits and vegetables for the years 2007-2014

Fruits and vegetables	$\bar{X} \pm S \bar{X}$	S ²	S	V%	\bar{X}_{max}
Aflatoxins	61.50±16.80	257.14	47.51	77.25	137.00
Deoxynivalenol DON	0.88±0.13	0.13	0.35	40.41	1.00
Fumonisine	0.75±0.16	0.21	0.46	61.72	1.00
Ochratoxina A	10.25±3.54	100.50	10.02	97.80	31.00
Patulin	0.25±0.2	0.50	0.71	282.84	2.00
Zearalenone	0.13±0.3	0.13	0.35	282.84	1.00

Within the group of spices and seasoning plants, in 2007 were 35 notifications regarding aflatoxins contamination at levels above the EU maximum level: pepper (20 notifications, of which 13 from India), paprika (4), nutmeg (3) and turmeric (2). Analyzing statistical data reported by RASFF on mycotoxin contamination of spices and

seasoning plants (for the period 2007-2014) can be seen the highest incidence of aflatoxins (21.0±6.8) followed by one for Ochratoxin A (6.9±2.2) and one for zearalenone (1.1±0.6); calculated coefficient of variation (V%) show a high variability of the data reported by RASFF (tab. 5).

Table 5 Mycotoxins contamination of seasoning spices and plants for the years 2007-2014

Seasoning spices and plants	$\bar{X} \pm S \bar{x}$	S ²	S	V%	\bar{x}_{max}
Aflatoxins	21.0±6.8	370.3	19.2	91.6	51.0
Deoxynivalenol DON	0.3±0.3	0.5	0.7	282.8	2.0
Fumonisin	0.6±0.6	3.1	1.8	282.8	5.0
Ochratoxina A	6.9±2.2	38.4	6.2	90.1	17.0
Patulin	0.4±0.2	0.3	0.5	138.0	1.0
Zearalenone	1.1±0.6	3.3	1.8	160.7	4.0

The notifications on aflatoxins in cereals and bakery products (16 notifications in 2007) focused in the main on rice (14 notifications, 11 of basmati rice from Pakistan and India). In the period 2007-2014, the average notifications concerning the

aflatoxin contamination was the highest (17.63) followed by ochratoxin A (3.88), DON (3.63) and fumonisins (2.38). For cereals and bakery products is noticed an very high homogeneity of the data reported by RASFF for the time period studied.

Table 6 Mycotoxin contamination of cereals and bakery products for the years 2007-2014

Cereals and bakery products	$\bar{X} \pm S \bar{x}$	S ²	S	V%	\bar{x}_{max}
Aflatoxins	17.63±4.71	177.13	13.31	4.71	75.51
Deoxynivalenol DON	3.63±1.38	15.13	3.89	1.38	107.29
Fumonisin	2.38±1.12	9.98	3.16	1.12	133.03
Ochratoxina A	3.88±0.93	6.98	2.64	0.93	68.19
Patulin	0.38±0.8	1.13	1.06	0.38	282.84
Zearalenone	0.63±0.4	1.41	1.19	0.42	190.04

In 2007 it was reported the presence of aflatoxins in different varieties of beans from Nigeria (8 notifications) and was recorded 10 notifications on aflatoxins in feed, especially those of seeds for bird feed (5), sunflower seeds from Egypt (3) and coconut in Côte d'Azur (2).

Also in 2007 was recorded 55 notices pertaining to other mycotoxins: ochratoxin A (30), deoxynivalenol (10), fumonisins (9) and zearalenone (6). Notifications concerning ochratoxin A relates mainly to the paprika powder (10) from Peru (8) and Spain (2). A cause of concern is very high level of ochratoxin in paprika powder from Peru (up to 280 mg/kg). They also reported nonconformities related to raisins (3), licorice (2), figs (2), cereals (3), honey cakes (4), instant products (4) and roasted coffee (2).

Notifications concerning *Fusarium* toxins: deoxynivalenol (10 notifications of which seven for cereals and three for the nuts and derivatives), zearalenone (six notifications of which three for cereals, two for feed and a notification for nuts and derived products) and fumonisins (nine notifications in cereals and bakery products), mainly relate to food.

Two notifications to very high levels of zearalenone in shell soy from Argentina

(intended for animal feed) deserve special attention. Since zearalenone is found in cereals and cereal products, finding the shell of soybeans it can be considered as fairly unusual. The presence of fumonisins in maize and products derived from it (originating in Italy) are subject of nine notifications in 2007 on this category of mycotoxins.

In 2008, as in previous years, the mycotoxins are reported in the highest number of notifications [9]. RASFF has received in 2008 a total of 931 notifications of the mycotoxins, of which no more than 902 for aflatoxins. This means that the downward trend of previous years is reversed, with an increase of 28% for aflatoxins and 23% for the mycotoxins in general. Proportionally, more referrals are made for aflatoxins as a consequence of the significant increase in of notifications for nuts, seeds and derived products. Cereal products deserve special attention because it refers to a growth trend that began in 2007 and continued in 2008. It can be seen a significant increase in of notifications (46 in 2008) on non-compliant levels of aflatoxins in cereals and cereal products compared to previous years (in 2007:17; in 2006:5 and in

2005:3 notifications). Those notifications refer to rice (28), mainly from Pakistan (19) and to a lesser extent from India (4), and the corn flour (18), predominantly from India (10) and Colombia (5). Could not be identified a cause for this increase of notifications. However for rice, increased control on the presence of aflatoxins in the EU, following the findings of Sweden on significant levels of aflatoxins in rice the end of 2007 would have contributed to this increased level of notifications in 2008. The same thing could be also in the increased numbers of notifications for aflatoxins in maize flour for which carried out an inspection in the EU after the initial finding of non-conformity.

The number of notifications on aflatoxins decreased significantly in 2009 (638) compared to 2008 (902). The reduction can be seen in all food categories, but for feed materials and for pet food can be seen an increase of notifications [10].

The findings of aflatoxins in cereals and bakery products mainly relate to basmati rice (8), and corn flour (4) from different regions and constitute a significant decrease compared to 2008 when they were 46 notifications for aflatoxins in cereals and bakery products of which 28 in basmati rice and 18 in maize flour. Of the 63 notifications regarding aflatoxins in the category of food, "fruit and vegetables" they are all on dried figs (60 notifications are only for dried figs from Turkey). It thus appears a significant decrease compared to 2008 (98 fewer notifications regarding aflatoxins from dried figs from Turkey).

From the category "herbs and spices" 23 notifications relate to different spices such as chilly powder, clove powder, nutmeg (of which 12 notifications concern products originating from India).

In category nuts, nut products and seeds 518 notifications on aflatoxins can be subdivided into:

- 218 notifications on groundnuts (peanuts) mainly from Argentina (73), China (58), the United States (19), Brazil (16), Egypt (15) and South Africa (9) etc;
- 136 notifications on pistachios mainly from Iran (57), Turkey (35) and the United States (32);
- 63 notifications on hazelnuts nearly all from Turkey (61);
- 55 notifications on almonds mainly from the United States (46) and a few from Australia (4);
- 7 notifications on Brazil nuts with 4 notifications on Brazil nuts in shell from Brazil and 3 notifications on Brazil nut kernels from Bolivia;
- 12 notifications on melon seeds mainly from Nigeria (7);
- 6 notifications on apricot kernels from Turkey (3) and Algeria (3).

Referring to aflatoxin contamination in 2009 of the feed materials, from nine notifications four refers to peanut, four for corn and sunflower seeds notification. Following the classical statistical analysis, the highest average value regarding mycotoxin contamination of feed (for the eight years studied) was recorded also for aflatoxins (38.00 ± 14.79) for other the mycotoxins, calculated average is below 0.75 (tab. 7).

Table 7 Mycotoxins contamination of feed for the years 2007-2014

Feed	$\bar{X} \pm S\bar{X}$	S ²	S	V%	\bar{X}_{max}
Aflatoxins	38.00±14.79	175.00	41.83	14.79	110.09
Deoxynivalenol DON	0.38±0.3	1.13	1.06	0.38	282.84
Fumonisine	0.75±0.37	1.07	1.04	0.37	138.01
Ochratoxina A	0.13±0.1	0.13	0.35	0.13	282.84
Patulin	0.63±0.38	1.13	1.06	0.38	169.71
Zearalenone	0.25±0.2	0.50	0.71	0.25	282.84

In the category of "spices and herbs seasoning", 13 notifications on ochratoxin A is mainly for paprika from Peru (8). For fruit and vegetable four notifications concern dried figs

(3) and raisins (a notice) in Turkey. The finding of high levels of ochratoxin A in two lots of pistachios from the United States is unusual (being the only ones notification made

for the 'nuts, and seeds derived products").

In 2010, there were 688 notifications related to mycotoxins: 649 for aflatoxins, 34 for ochratoxin A, two for deoxynivalenol three for fumonisins [11]. The number of RASFF notifications for mycotoxins in 2010 is in the same range as the number from 2009 but is significantly lower compared to 2008.

Comparing 2010 with 2009 there are a few significant differences within product categories notified. While the in 2010 increase the notifications on aflatoxins for peanuts (260) compared to 2009 (233), there is an important reduction of their in the nuts and derived products (168 in 2010 compared to 283 in 2009). This is related to changes in EU legislation through which maximum levels for aflatoxins in almonds, hazelnuts and pistachios were aligned with the maximum levels provided by the Codex Alimentarius. Unacceptable presence of ochratoxin A in 2010 (34 notifications) refers to raisins from Uzbekistan (9), to chilli from Peru (6), to raisins from Turkey (4), to different cereals (rice, rye, millet, maize) from different origins (India, Lithuania, Ukraine and USA), to coffee and red wine.

In 2011, the number of notifications relating to mycotoxins has decreased (585), a fact that was due to decrease in the number of notifications on aflatoxins (tab. 1). Also in 2011 there were 35 notifications relating to the presence of ochratoxin A in: paprika (17), fruits and vegetables (10), bakery (5) and others (3) [12].

In 2012, the number of notifications for mycotoxins decreased significantly (table. 1) due to lower aflatoxin contamination (484). This decrease can be explained mainly by the significant reduction of notifications concerning the presence of aflatoxins in certain products with consolidated verification regime [13]. On the other hand, it could be observed a significant increase in notifications relating to presence of aflatoxins in dried figs from Turkey (135). From the notifications on aflatoxins of groundnuts, 21 refer to peanuts intended for pet food (bird feed) from Argentina (7) Brazil (11) and India (3). A sharp increase in RASFF notifications concerning the aflatoxins in spices refers to spices from India, for which an increased frequency of import

controls is into force from 25 January 2010. Also in 2012, 32 notifications were related to the presence of unacceptable of ochratoxin A for the category "fruit and vegetables" (19), mainly in raisins from Afghanistan (5), Uzbekistan (6) and Turkey (4), cereals and bakery products (6) for spices (4) and other (3).

In 2013, the number of notifications of mycotoxin contamination further decreased significantly being due to a decrease in notifications concerning aflatoxins in peanuts from India (88 notifications in 2012 to 15 in 2013) and the dried figs from Turkey (from 135 notifications in 2012 to 40 in 2013). On the other hand, in 2013 have been recorded a significant number of notifications regarding the aflatoxins in maize from European region [14]. The south Region of Europe has been affected by a severe drought during the growing season of maize in 2012, resulting in an increase spread of aflatoxins in corn crop from this area. Several RASFF notifications from this region linked to a level above the maximum permissible limit of aflatoxins in corn, were issued at the end of 2012 and 2013, most of in feed corn from Bulgaria, Romania, Serbia, Ukraine, Hungary, Spain, Slovakia, Greece and Italy. Out of 37 notifications from the category animal feed, only nine regards aflatoxins from peanuts from different origins. Most notifications, 21, targeted corn products from Southeast Europe.

A total of 54 notifications were related to presence unacceptable of ochratoxin A, an important growth comparable to 2012. There have been 31 notifications for ochratoxin A for the category "fruit and vegetables", especially in dried figs from Turkey (13 notifications) and raisins in Afghanistan (5), Uzbekistan (4), Turkey (3) and Iran (2). There were eight notifications in "spices and herbs seasoning" among which the curry powder from India (3) and 5 notifications in category "cereals and bakery products", especially rye products. The subject of five notification was the coffee and of three notifications, grape juice. Finally peanuts and almonds were found occasionally with a high content of ochratoxin A.

In 2014 the total number of notifications of mycotoxin contamination further decreased, reaching out to 383 (357 for food

and 26 feed) [15]. Of these, 296 notifications have been for aflatoxins (259 for the category nuts, seeds and derived products (originating from Iran, China and Turkey) and 37 for fruit and vegetable products originating from Turkey), 57 for ochratoxin A, 10 for DON, 9 for fumonisins, 6 for patulin and 5 for zearalenone (table 1).

Out of 26 notifications concerning of aflatoxins levels measured from the raw material for animal feed all exceeded legal limits 12 notifications were aimed peanuts in Sudan, most frequently declared country of origin; 10 notifications concerned the corn of various origins, six of them from India, one of them having a very high level of contamination, over 40 times the legal limit (881 ppb).

CONCLUSIONS

The downward trend of notifications recorded regarding mycotoxins contamination of food and feed reveals the utility functioning of RASFF. If in one year is observed a much higher level of contamination of a particular product (compared to previous years) is intensifying its automatic import controls the purpose pursued being represented by controlling the hazard to consumers' health and animals. In recent years, however a problem was brought before, regarding the presence of aflatoxins in corn, in particular, but also in other products, even if the controls have been performed before placing them on the EU market. This was because aflatoxins contamination in a batch is very heterogeneous, and samples taken of economic operators for checking conformity with EU maximum levels have proven to not always be representative for the lot. More, it was observed lack of communication between different operators concerning the results obtained and of the method of sampling. A guidance document under discussion at the European Council and implicitly of European Economic Area, to address of these shortcomings.

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