

ANALYSIS OF THE INCIDENCE OF FOREIGN BODIES IN EUROPEAN FOODS

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ABSTRACT

This paper contains a comprehensive review of different types of foreign matter reported in Rapid Alert System for Food and Feed (RASFF) during the period 2016 – 2018. It provides information on incidents of foreign matter contamination discussed and mined in terms of types of foreign bodies, food products involved and geographic distribution within indicated European regions. By analysing the presence of foreign bodies in different European regions (Eastern, Northern, Southern, Western Europe), we found, by means of statistical evaluation, that there were differences in some of the data obtained with respect to the country reporting a foreign body. We found that plastic, glass and metal were the most commonly reported in Western Europe, pests and rubber in Northern Europe. As far as food commodities are concerned, bakery and confectionery products, fruit and vegetables and convenience foods were most frequently reported and the notifications came most often from Western Europe. Notifications from this part of Europe were made with regard to other monitored commodities as well. Regarding the notification type, the most frequent one was an alert and, in the case of a risk decision, serious risk constituted the largest part.

Keywords: Rapid alert system for food and feed (RASFF), foreign bodies, physical hazards, european foods

INTRODUCTION

The food safety is the main concern of the politicians and inhabitants in whole Europe. According the currently valid legislation the food should be safe. The food should be safe from all aspects: chemical, microbiological, physical and radiological (Svrčinová *et al.*, 2019).

Several studies have been conducted in previous years to investigate the level of food safety knowledge among food handlers working in restaurants and catering (Sun *et al.*, 2012; Panchal *et al.*, 2013; Pichler *et al.*, 2014), small businesses (Gomes-Neves *et al.*, 2011), and meat processing plants (Ansari-Lari *et al.*, 2010; Jianu and Golet, 2014). However, there was no such research related to physical contaminants and food safety knowledge among food handlers. Hence foreign bodies can range from items that are demonstrably alien to the food, such as pieces of glass, metal or plastic through items that are related to the food, such as fragments of bone in meat products to part of the food itself, such as crystals of sugar or salt that are mistaken for glass (Edwards, 2014). Metallic foreign bodies can occur in foods as a result of contamination of raw materials and their improper quality control during reception into the plant, improperly conducted production processes, employees' negligence, inadequate state of machines and equipment (Codex Alimentarius, 2014). In many countries the occurrence of foreign bodies is the most common cause of detected defects in foods (Edwards and Stringer 2007). Food manufacturers are very careful when it comes to detection of foreign bodies in food because it can lead to injury to customers. This, in turn, can cause loss of loyalty as well, recalls and rejections. Food safety and quality control are essential parts of the food industry. In practice there should be measures taken by companies to eliminate or reduce the risk of foreign body contamination (Mattos *et al.*, 2016). As a support in assuring safety of food and animal feed on the European market, the European Union (EU) has established the Rapid Alert System for Food and Feed (RASFF) in line with the "General Food Law" (European Union, 2015). This interactive database enables exchange of information regarding measures taken in respect to various aspects of food safety and food fraud (Bouzemrak and Marvin, 2016). The European Commission Maintains the Rapid Alert System for Food and Feed (RASFF) (European Union, 2018). RASFF is an exchange tool on food and feed risk control measures. RASFF data provide useful up-to-date and real-life information for risk analysis. The presence of foreign bodies in food is one of the main problems in food industry and the number of notifications filed to the Rapid Alert System for Food and Feed (RASFF) confirms the importance of the

problem (European Union, 2017). In the USA, a study of foreign bodies in food was performed by Mattos *et al.* (2016). They conclude that although some foreign matter found are considered as unavoidable, further development of control mechanisms should be supported throughout food processing (Djekic *et al.*, 2017).



Picture 1 Foreign bodies in Food (Incidents annual report, 2018)

MATERIAL AND METHODS

Evaluation of foreign particles using RASFF notifications

We analysed the presence of foreign bodies using notifications in the Rapid Alert System for Food and Feed (RASFF) during the years 2016, 2017 and 2018. All research information was obtained from the RASFF web portal. The records we obtained using the portal and weekly reports contained the following information:

- the classification of the given notification, whether it was an alert, border rejection, information, information for attention or information for follow-up;
- the date of the specific notification of a foreign body in food;

- the notifying country;
- the object (foreign body) contained in contaminated food (metal, glass, plastic, wood, etc.);
- the specific product in which a foreign body was found (biscuits, cheese, walnuts, etc.);
- the food commodity in which the product is included (cereals and bakery products, milk and dairy products, convenience foods, etc.);
- the risk decision classified as serious, not serious or undecided.

Regarding the evaluation of the whole reference period, we compared the number of notifications in the RASFF in individual years and we also evaluated notifications based on the type of a foreign body, food commodity and the type of a notification. We divided these data according to notification localisation into Eastern, Northern, Southern and Western Europe. At the same time, we statistically calculated the p-value for individual data to see if there was a difference in the data obtained.

The specific reference period was chosen to compare our results with the scientific article published by Djekic *et al.* (2017). This article describes an analysis of the presence of foreign bodies using data from the RASFF database in the period 1998 – 2015. We compared our data with the authors' data and subsequently established trends in the presence of foreign bodies for the reference period.

In the last part, we dealt with the comparison of the presence of foreign bodies in respect of all monitored risks using the RASFF database.

Table 1 The incidence of foreign bodies in Europe for the years 2016, 2017 and 2018

Country presence of foreign bodies	The number of presence of foreign bodies in pieces			Country presence of foreign bodies	The number of presence of foreign bodies in pieces		
	2016	year 2017	2018		2016	year 2017	2018
Germany	31	25	28	Norway	2	2	1
Netherlands	13	11	16	Lithuania	2	2	0
Great Britain	12	10	12	Romania	1	0	0
Italy	11	15	10	Poland	2	5	3
France	9	8	16	Greece	2	0	0
Sweden	8	3	5	Switzerland	2	3	2
Denmark	8	20	21	Iceland	1	0	0
Austria	7	4	8	Slovakia	1	1	0
Ireland	5	1	1	Estonia	1	1	1
Belgium	3	4	10	Luxemburg	1	0	0
Finland	2	1	7	Czech Republic	0	7	1
Spain	2	2	4	Hungary	0	1	2
Slovenia	0	0	3	Portugal	0	1	
Malta	0	0	1	Croatia	0	1	1
				plastic	24	27	49
				rubber	4	1	0
				stone	2	4	1
				wood	1	4	0
				paper	0	1	0
				bones	0	0	1
				other	10	8	15

There were 128 notifications in 2016, Slovakia reported the presence of foreign bodies only once. Regarding our country, the notification involved glass fragments in chicken liver and the risk was classified as serious. Slovakia was also associated with one notification from Estonia, where a caterpillar was found in tomato sauce, which had been made in our country. However, this notification was classified as not serious. In 2017 there were 128 reports as well. Again, Slovakia made one notification of the presence of foreign bodies in food. This case involved sharp fragments in a canned cod. The year 2018 saw the most notifications for the whole reference period, namely 153. In Slovakia, no notification of the presence of foreign bodies was reported that year.

Table 2 Subjects of foreign bodies in the years 2016, 2017 and 2018

Items foreign bodies	The number of presence of foreign bodies in pieces (year)		
	2016	2017	2018
pests	34	29	19
glass	27	29	32
metal	26	25	36

Table 3 Presence foreign bodies in food commodities in 2016, 2017 and 2018

Food commodities	The number of presence of foreign bodies in pieces (year)			Food commodities	The number of presence of foreign bodies in pieces (year)		
	2016	2017	2018		2016	2017	2018
	fruits and vegetables	23	21		16	poultry	4
cereals and bakery products	20	24	28	herbs and spices	4	2	1
intermediate products	13	15	17	alcohol	3	0	1
milk and milk products	12	7	14	fish and their products	3	6	6
nuts and	9	9	8	ice cream	2	2	3

To evaluate the data acquired and find differences in them, we used the Chi-square test using the R program. The p-values calculated to determine if there was a difference in our data are given in the tables included the study itself. P-values were determined for each line in the tables to see if there were differences in the given data within European regions in the number of foreign body notifications. We also determined p-values for each column of the table and thereby came to the conclusion on whether there were any differences across the whole analysed group in one European region. If the p-value is less than 0.05, there is a difference in the data; if it is greater than 0.05, there is no difference in the data.

RESULTS AND DISCUSSION

Evaluation of RASFF data for the period 2016 – 2018

When evaluating notifications of the presence of foreign bodies from the RASFF for the years 2016, 2017 and 2018, we found a total of 409 notifications reported to the RASFF system. In analysing these three years, we first focused on the very evaluation of RASFF notifications. We evaluated three specific areas, namely which countries most notifications came from, what foreign body was most frequently found in food, and what food commodity had the most frequent presence of foreign bodies.

In 2016 the most reported types of foreign bodies in Europe were pests (34 pieces), glass (27 pieces), metal (26 pieces) and plastic (24 pieces). Furthermore, there were objects such as rubber (4 pieces), wood (1 piece) or stone (2 pieces). We classify as others such items that were found in low numbers and in 2016 these included, for example, rodent faeces, part of a slicer or electric cable, hard glue parts, batteries and foam structure. In 2017 and 2018 the most frequently reported foreign bodies were glass, pests, plastic and metal.

seeds							
soups, sauces	7	4	3	honey and royal jelly	1	-	2
cocoa, tea, coffee	7	4	4	cephalopods and products thereof	1	2	0
meat and products thereof	7	4	8	additives	1	0	3
other	6	10	11	diet, fortified foods	0	2	4
confectionery	5	10	14	non-alcoholic drinks	0	2	3

The number of reports in the period 2016 - 2018 had increasing character. In 2016 it was 128 reported in 2017 and again 128 in 2018 to 153 reports of the presence of foreign bodies in foods. Visual display of messages is presented in the graph in Figure 1.

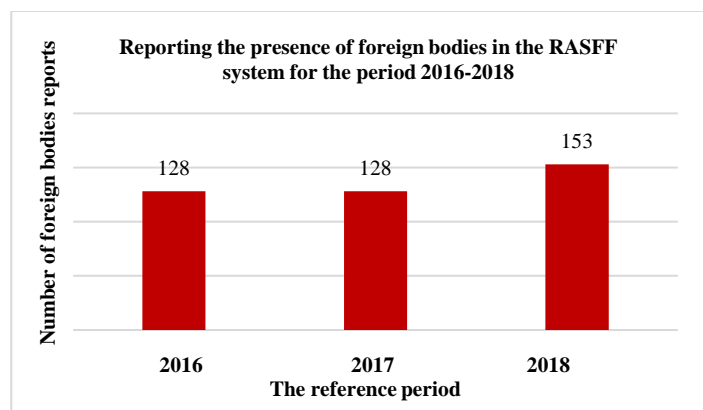


Figure 1 Graphical representation of reports of foreign bodies in the database RASFF in the period 2016, 2017 and 2018.

Djekic et al. (2017), with whom we compared our data, based the subject analysis of the presence of foreign bodies on RASFF notifications for the years 1998 – 2015. Altogether 1,446 notifications of foreign bodies were reported over this reference period. In this article the authors collected data on the presence of foreign bodies before 2006 into one category, analysing each year separately from that year.

By combining our data and the data on the presence of foreign bodies given by Djekic et al. (2017), we created a chart to find out what trend is typical of the presence of foreign bodies according to notifications in the RASFF for the period 1998 – 2018. The trend line points to the fact that the number of notifications from a 20-year perspective is slightly decreasing. However, we can observe an annual increase in the number of foreign body notifications from 2013.

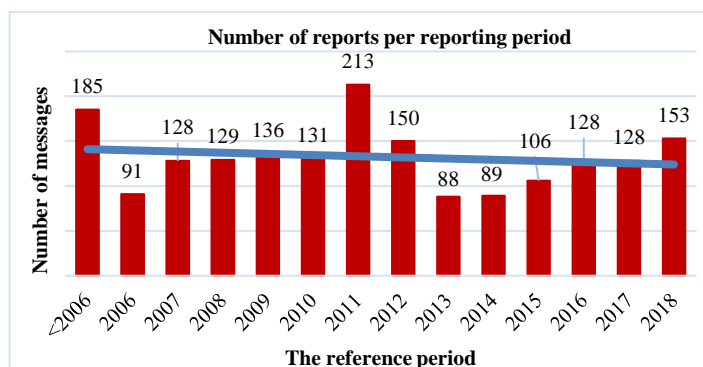


Figure 2 The number of reports of foreign bodies in the RASFF in the period 1998 – 2018.

Table 4 The presence of foreign bodies in regions of Europe with regard to the type of foreign bodies

Type of foreign bodies	Eastern Europe	Northern Europe	Southern Europe	Western Europe	Chi2 p-value	the amount
bones	0	1 (100%)	0	0	0.3916	1 (100%)
glass	5 (5.68%)	18 (20.45%)	6 (6.82%)	59 (67.05%)	p <0.05	88 (100%)
metal	3 (3.41%)	28 (31.82%)	8 (9.09%)	49 (55.68%)	p <0.05	88 (100%)
pests	7 (8.54%)	33 (40.24%)	31 (37.81%)	11 (13.41%)	p <0.05	82 (100%)
plastic	4 (4%)	32 (32%)	4 (4%)	60 (60%)	p <0.05	100 (100%)
rubber	0	4 (80%)	0	1 (20%)	0.03511	5 (100%)
stone	0	2 (28.57%)	1 (14.29%)	4 (57.14%)	0.1718	7 (100%)
wood	1 (20%)	1 (20%)	1 (20%)	2 (40%)	0.8964	5 (100%)
other	4 (12.12%)	11 (33.34%)	3 (9.09%)	15 (45.45%)	0.007488	33 (100%)
chi2 p-value	0.0124	p <0.05	p <0.05	p <0.05		

Presence of foreign bodies in European regions

When analysing the presence of foreign bodies in the Rapid Alert System, we also looked at the frequency of presence with respect to individual European regions. We divided the territory of Europe according to regions into Eastern, Northern, Southern and Western Europe. Based on the number of notifications, we dealt with division – according to the type of a foreign body, food commodity and the type of a notification. At the same time, we also present the p-value of the Chi-square test in the relevant tables, which indicates whether or not there is a difference in the values found. If the p-value is less than 0.05, it means that there is a difference in the data, and vice versa, if it is greater than 0.05, there is no difference in the data.

The numbers of notifications based on the type of a foreign body are presented in Table 4. Differences in the number of notifications and European regions were found in the case of foreign bodies of glass, metal, pests, plastic, rubber and others. In these cases, the p-value was less than 0.05. Regarding the difference in types of foreign bodies within one region, differences in the number of notifications were found in all 4 regions. By comparing the absolute values of the number of notifications, we can state that glass, metal, and plastic were most prevalent in Western Europe and pests and rubber were most commonly reported in Northern Europe. The group of foreign bodies classified as others, which were present in low numbers and which included e. g. glue, thermometer, part of a slicer or a human tooth, were most frequently reported in Western Europe.

In their article Mattos et al. (2016) identified the most common types of foreign bodies – grain fragments, insects and its larvae, dead mites and rodent faeces. The presence of particles such as metal, glass or wood, which can seriously damage human health, was reported as rare. Aguiar et al. (2018) identified the most significant foreign bodies in milk – insects, hair, plastic, metal and fabric. In their article Djekic et al. (2017) stated that, based on their research in 1998 – 2015, pests, glass and metal were the most common types of foreign bodies. In our analysis for the years 2016 - 2018, plastic, glass, metal and, to a considerable extent, also pests were most frequently reported. Further, in their research Djekic et al. (2017) found that glass and metal were most commonly reported in Western Europe, pests in Eastern Europe and plastic, rubber and wood in Northern Europe. As for the foreign bodies of glass, metal and the group of others, our results are consistent with their analysis. The difference was mainly in the case of pests and plastic, which in our reference period were most frequently present in other parts of Europe than those reported in the article with which we compared our results.

It is an interesting fact that metal as a foreign body is still one of the most frequently reported items in spite of the extensive introduction and use of metal detectors in food processing plants. In their article Losito et al. (2011) reported on research pointing out that the nonuse of metal detectors in food processing plants is one of the greatest risks in food safety.

The division of food commodities into individual European regions based on the number of notifications is shown in Table 5. By calculating the p-value of the Chi-square test, we found that there was a difference in the number of notifications and the regions from which these notifications came in the case of meat, milk and dairy products, fruit and vegetables, bakery and confectionery products, convenience foods as well as in the group of others. When comparing individual food commodities within one European region, there was no difference apart from Eastern Europe. According to Djekic et al. (2017), notifications regarding meat came most frequently from Western Europe, fruit and vegetables were most frequently reported in southern countries and bakery and confectionery products in Northern Europe. According to our results, the only notifications that correspond with the article are those regarding meat, which came most frequently from Western Europe. For the period 2016 – 2018, fruit and vegetables and bakery and confectionery products were most frequently reported in Western European countries. In the aforementioned article by Djekic et al. (2017) the most frequently reported items for the presence of foreign bodies

in the reference period were fruit and vegetables, nuts and seeds and bakery and confectionery products. In our case, bakery and confectionery products ranked first in the number of notifications, followed by fruit and vegetables and convenience foods also showed a higher number of notifications. In the research conducted by Mattos et al. (2016) in 2001 – 2015, bakery and confectionery products also ranked first with regard to the presence of foreign bodies in food. In their publication Edwards and Stringer (2007) identified three categories of products that were most commonly reported in association with the presence of foreign bodies. These were fruit and vegetables, nuts and seeds and bakery and confectionery products. Our results confirmed that the most commonly reported food commodity was bakery and pastry products, fruit and vegetables, which is consistent with the assertion in the article. However, in our analysis the commodity of nuts and seeds with the number of notifications 26 ranked next to last of the commodities examined.

Table 5 The presence of foreign bodies in the regions of Europe due to food commodities

Food commodities	Eastern Europe	Northern Europe	Southern Europe	Western Europe	Chi2 p-value	the amount
beverages	1 (11.12%)	4 (44.44%)	0	4 (44.44%)	0.129	9 (100%)
meat	4 (12.12%)	12 (36.36%)	1 (3.04%)	16 (48.48%)	p <0.05	33 (100%)
milk and milk products	1 (3.04%)	11 (33.33%)	3 (9.09%)	18 (54.54%)	p <0.05	33 (100%)
fruits and vegetables	2 (3.33%)	17 (28.33%)	18 (30%)	23 (38.34%)	p <0.05	60 (100%)
nuts and seeds	4 (15.38%)	8 (30.77%)	6 (23.08%)	8 (30.77%)	0.6386	26 (100%)
pastry and confectionery	5 (6.95%)	25 (34.72%)	14 (19.44%)	28 (38.89%)	p <0.05	72 (100%)
intermediate products	0	9 (20%)	1 (2.22%)	35 (77.78%)	p <0.05	45 (100%)
other	7 (5.34%)	44 (33.59%)	13 (9.92%)	67 (51.15%)	p <0.05	131 (100%)
chi2 p-value	0.06439	p <0.05	p <0.05	p <0.05		

Regarding individual types of notifications and their incidence within European regions, differences based on p-values were found in the notification type, except for information for follow-up. In addition, when comparing all types of notifications for each region, we found that there were differences in these data. The numbers of notifications for individual notification types are listed in Table 6.

Djekic et al. (2017) found that for the period 1998 – 2015 alerts were most frequently reported and prevailed mainly in Western and Northern European

countries. We came to the same conclusions in our study. According to them border rejections were reported mainly in Eastern European countries, but we found that in our reference period border rejections had been reported mainly in Southern Europe. In addition, according to our findings, information notifications were most prevalent in Western Europe and information notifications for attention were most frequently reported in Northern and Southern Europe with the same incidence.

Table 6 The presence of foreign bodies in the regions of Europe due to the type of notification

Type notice	Eastern Europe	Northern Europe	Southern Europe	Western Europe	Chi2 p-value	the amount
warning	10 (3.98%)	73 (29.08%)	19 (7.57%)	149 (59.37%)	p <0.05	251 (100%)
rejection at borders	6 (20.69%)	7 (24.14%)	15 (51.72%)	1 (3.45%)	0.003049	29 (100%)
information	2 (7.14%)	7 (25%)	3 (10.71%)	16 (57.15%)	p <0.05	28 (100%)
information-inspiring attention	1 (6.67%)	5 (33.33%)	5 (33.33%)	4 (26.67%)	p <0.05	15 (100%)
information for follow-up	5 (5.81%)	37 (43.02%)	13 (15.12%)	31 (36.05%)	0.4126	86 (100%)
chi2 p-value	0.0316	p <0.05	0.002184	p <0.05		

We distinguish three types of risk decisions - serious, not serious and undecided. During the 2016 – 2018 reference period, serious risk was present in 63.6% of cases, not serious in 23% of cases and undecided only in 13.4% of cases (Table 7). In their analysis of the years 1998 – 2015, Djekic et al. (2017) reached substantially different results. Most of the risks were classified as undecided (78.3%), than came risks which were not serious (11.8%) and the least frequent risk decisions were serious (9.9%).

Table 7 The decision on risk for the period 2016 – 2018

The decision on risk	The number of reports 2016 – 2018	%
seriously	260	63.6%
minor	94	23%
undecided	55	13.4%

Comparison of the number of foreign body notifications with other risk types in the RASFF database

During manufacture, handling, or distribution to the market all foods are exposed to a wide variety of risks. In the Rapid Alert Database individual risks are divided into as many as 29 categories. As our study deals with the presence of foreign bodies in food, we needed to find the proportion of foreign bodies in respect of all risks that can be reported to the RASFF system.

When comparing the number of notifications in the RASFF database, we found that in each reference year foreign bodies were found in the top ten of all types of monitored risks. As can be seen in Table 8, in 2016 foreign bodies accounted for 4.36%, in 2017 3.39% and in 2018 even 4.49% of all risk notifications. As expressed by Goodwin (2014) in his article, the risk of physical contamination has not changed significantly over a period of several years, which is confirmed by the data obtained from the RASFF database. The findings show that physical contamination is a permanent problem that can never be completely eliminated. Nevertheless, foreign bodies pose a relatively low risk compared to

other categories. The cases of market withdrawals that are more dangerous and more frequently happening are related to mycotoxins or the presence of microorganisms or pesticides in food.

According to the 2006 – 2015 annual reports published by the UK Food Standards Agency (FSA) (**Incidents Annual Report, 2018**), the amount of foreign bodies ranges from 4% to 10% relative to other risks. The highest percentage of foreign bodies was in 2006, namely 10.34%. Since that year, values

have been declining annually, while in recent years we have observed an insignificant increase and decrease in values representing the presence of foreign bodies in food in the range of 4 – 6%. Again, these data confirm that the presence of foreign bodies in food cannot be completely eliminated. As this value does not increase significantly, the measures that are used to control the presence of foreign bodies in food are properly applied.

Table 8 The number of reports of all kinds of risks RASFF database

	2016 (year)		2017		2018	
	count reports	%	count reports	%	count reports	%
food adulteration / fraud	114	3.71%	184	4.77%	86	2.30%
allergens	113	3.67%	144	3.73%	168	4.49%
biological contaminants	43	1.40%	51	1,32%	46	1.23%
chemical contaminants (other)	1	0.03%	0	0.00%	3	0.08%
incorrect composition	174	5.66%	153	3,96%	217	5.80%
environmental pollutants	51	1,66%	39	1.01%	53	1,42%
feed additives	3	0.10%	1	0.03%	4	0.11%
additives	168	5.46%	178	4.61%	177	4.73%
foreign bodies	134	4.36%	131	3.39%	168	4.49%
GMO	15	0,49%	16	0.41%	13	0,35%
metals	218	7.09%	279	7.23%	181	4.84%
new food	78	2.54%	178	4.61%	51	1.36%
industrial contaminants	9	0,29%	8	0,21%	24	0.64%
incorrect labeling	28	0,91%	28	0.73%	51	1.36%
migration	78	2.54%	63	1.63%	79	2,11%
natural toxins	26	0,85%	29	0.75%	32	0.86%
mycotoxins	549	17.85%	579	15.00%	655	17.51%
pathogenic microorganisms	261	8.49%	260	6.74%	331	8.85%
other	7	0,23%	9	0,23%	11	0,29%
organoleptic aspects	41	1,33%	30	0.78%	33	0.88%
faulty packing	25	0.81%	31	0.80%	31	0.83%
parasites	23	0.75%	41	1.06%	41	1,10%
pathogenic microorganisms	505	16.42%	870	22.54%	782	20.90%
pesticide residues	251	8.16%	337	8.73%	278	7.43%
lack of control	97	3.15%	115	2.98%	136	3.64%
process contaminants	3	0.10%	23	0.60%	13	0,35%
radiation	5	0.16%	11	0.28%	14	0.37%
residues of veterinary medicinal products	47	1.53%	64	1.66%	49	1.31%
TSE	8	0.26%	8	0.21%	14	0.37%
THE AMOUNT	3075	100%	3860	100%	3741	100%

CONCLUSION

By analysing the presence of foreign bodies in different European regions (Eastern, Northern, Southern, Western Europe), we found, by means statistical evaluation, that there were differences in some of the data obtained with respect to the country reporting a foreign body. We found that plastic, glass and metal were most commonly reported in Western Europe, pests and rubber in Northern Europe. As far as the food commodity is concerned, bakery and confectionery products, fruit and vegetables and convenience foods belonged to the most frequently reported and the notifications came most often from Western Europe. Notifications from this part of Europe were made in respect of other monitored commodities as well. Regarding the notification type, the most frequent one was an alert and, in the case of a risk decision, serious risk constituted the largest part. The last task in evaluating the presence of foreign bodies in the RASFF system was to determine the proportion of foreign bodies in respect of all other risks reported to the RASFF. Based on our analysis, we judge that in each reference year the proportion of foreign bodies was around 4%, which represents a relatively significant value.

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