



THE CORRELATION ANALYSIS OF ALERT NOTIFICATIONS IN THE RASFF TO FOOD FROM THE NON-EEA COUNTRIES AND FROM THE EEA COUNTRIES

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ABSTRACT. Background: The RASFF (Rapid Alert System for Food and Feed) is used to quickly mutual information of member countries of the European Economic Area (EEA) on risks in food. A similar trend line course of alert notifications in the RASFF in time to food from the non-EEA countries and the EEA countries, as well as a very high value of the Pearson's r correlation coefficient (0.96) indicated an interdependence of alert notifications from these two groups of countries. Therefore, the goal of the article was to examine the strength of correlation within particular products categories and hazards categories.

Methods: Data for the study came from the RASFF database from the years 1979-2013 covering 8175 alert notifications, including the 2540 notifications to food from the non-EEA countries and 5635 notifications to food from the EEA countries. Within each products category and hazards category examined whether there was a correlation (i.e. the value of calculated statistics t exceeded the value of critical statistics $t_{0.05;n-2}$), and then calculated the Pearson's r correlation coefficient.

Results: The value of Pearson's correlation coefficient indicated the occurrence of a very high correlation in the products category "Herbs and spices" (0.98), and the high correlation in the following categories: "Bivalve molluscs and products thereof" (0.70), "Dietetic foods, food supplements fortified foods" (0.86), "Fish and fish products" (0.79), "Food contact materials" (0.89), "Fruits and vegetables" (0.88) and "Meat and meat products (other than poultry)" (0.72). However, in the case of hazards categories the very high correlation occurred in the category of "Food additives and flavourings" (0.93) and "Radiation" (0.94) and the high correlation in the case of "Composition" (0.89), "Foreign bodies" (0.88), "Heavy metals" (0.80), "Mycotoxins" (0.81) and "Pathogenic micro-organisms" (0.72).

Conclusions: The results showed the need to pay particular attention by the border control authorities to food which is imported: seafood, herbs and spices, and fruits and presented in this food: heavy metals, pathogenic micro-organisms and mycotoxins. It would also shorten the supply chain and / or limit the import of certain raw materials and products, directing the attention of consumers to food produced first of all in the EEA.

Key words: EEA, RASFF, alert notifications, products categories, hazards categories, correlation analysis.

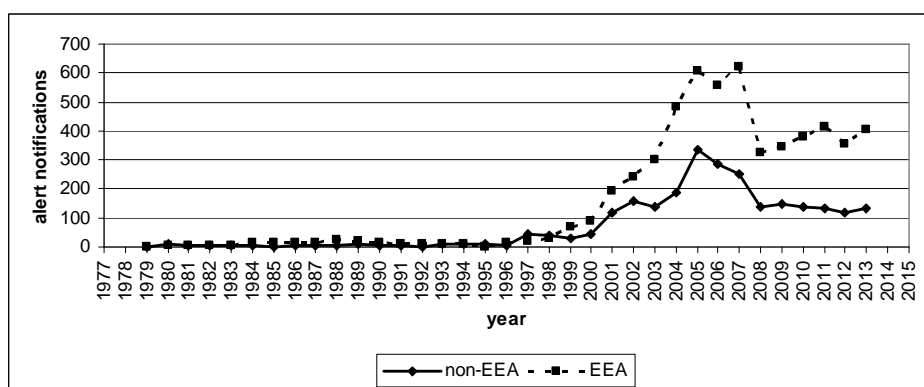
INTRODUCTION

The RASFF (Rapid Alert System for Food and Feed) is a tool for cross-border exchange of information on the risks to public health in the food chain. This system was developed already in 1979, but his legal status was established in the Regulation No 178/2002 [Bilska and Kowalski 2014, European Commission 2014]. Currently, members of the

RASFF are 28 member states of the European Union (EU), the other three countries of the European Economic Area - EEA (Norway, Iceland and Liechtenstein) - total 31 countries, Switzerland, European Commission, European Food Safety Authority and EFTA (European Free Trade Association) Surveillance Authority. Within the RASFF are sent four types of notifications: alert notifications, information, border rejections and news [European Commission 2014].

Van de Brug et al. [2014] believes that the RASFF as being based on existing knowledge of known hazards cannot be applied to new or unexpected hazards. It should, however, pay attention to the trends that can be observed thanks to functioning of the RASFF. A similar trend line shape of number of the number of alert notifications to food from non-EEA and

EEA countries in the period 1979-2013 (Fig. 1) may indicate a correlation interdependence of these notifications. Dabbene et al. [2014] points out that increases the amount of food withdrawals from the market. He also notes that it may be due to rising imports from countries where food safety requirements are at a lower level.



Source: Own study on the basis [European Commission 2014]

Fig. 1. The alert notifications within the RASFF to food from the non-EEA and the EEA countries in the period 1979-2013

Rys. 1. Powiadomienia alarmowe w systemie RASFF wobec żywności z krajów spoza EOG i z krajów EOG w latach 1979-2013

The value of Pearson's r correlation coefficient between the alert notifications of the RASFF to food from the non-EEA and EEA countries amounted 0.96, which indicated very high correlation - see [Crewson 2008] (with value of calculated statistics t of 20.51, exceeding the value of the critical statistics $t_{0.05;n-2}$ of 2.03). It can be assumed that EEA countries import raw materials and then use them for the food production or import the final products, which are then repackaged and sold, including also re-export within the EEA.

Therefore, the goal of this article was to examine the strength of correlations within each product category and hazard category, with particular emphasis on those categories, where the correlation was the highest.

MATERIALS AND METHODS

The material for the study came from the RASFF database and covered the years 1979-2013. In this period, there were 8175 alert

notifications, including 2540 (31%) to food from the non-EEA countries and 5635 (69%) to food from the EEA countries. In the case, if as the product origin were given several countries, the first mentioned country was adopted as eligible to the group of the non-EEA or EEA countries.

The alert notifications to food from the non-EEA countries (variable X) were adopted as values of x_i and alert notifications to food from the EEA countries (variable Y) were adopted as values of y_i . The study of the inverse relationship would be unreasonable due to the fact that the RASFF is designed to protect the consumers from the EEA and also because of thesis put in Introduction (relating to the import of raw materials or products into the EEA).

In the analyzed period 1979-2013 the number of observations n (number of years) amounted 35. However, within each product category and hazard category, it was limited only to the years (and not in every case occurring one by one), in which there was at

least one alert notifications in the RASFF to food from the non-EEA or EEA countries (so, the number of observations n was different).

RESULTS AND DISCUSSION

In Table 1 presented the values of critical statistics $t_{0.05;n-2}$, the calculated statistics t and Pearson's r correlation coefficients for the products categories, and in Table 2 for the hazards categories. The value of the critical statistics $t_{0.05;n-2}$, set at a significance level of 0.05, and with the number of degrees of freedom $n-2$.

Taken into account only these categories, where the number of observations n was at

least 5 - see [Crewson 2008]. In the case of the products categories, the categories which are already "obsolete" were not included, because it would be unfounded. There was not also examined the correlation in the hazard category "Transmissible spongiform encephalopathies" (TSEs), because within this category the alert notifications to food from non-EEA countries didn't occur. After considering the adopted assumptions, examined 28 out of 35 products categories (within these categories there were 7907 alert notifications, which represented 97% of the population) and 25 out of 26 hazards categories (within these categories there were 8138 alert notifications, which represented 99% of the population).

Table 1. The values of critical statistics $t_{0.05;n-2}$, the calculated statistics t and Pearson's correlation coefficients r for the products categories

Tabela 1. Wartości statystyki krytycznej $t_{0.05;n-2}$, statystyki obliczonej t oraz współczynnika korelacji Pearsona r dla kategorii produktów

Product category	$t_{0.05;n-2}$	$ t $	r
Alcoholic beverages	2.18	$ -1.31 =1.31$	-
Bivalve molluscs and products thereof	2.36	2.60	0.70
Cephalopods and products thereof	2.57	$ -0.70 =0.70$	-
Cereals and bakery products	2.08	3.54	0.61
Cocoa and cocoa preparations, coffee and tea	2.07	3.07	0.54
Confectionery	2.12	1.52	-
Crustaceans and products thereof	2.07	3.06	0.55
Dietetic foods, food supplements, fortified foods	2.09	7.20	0.86
Eggs and egg products	2.12	0.54	-
Fats and oils	2.14	0.34	-
Fish and fish products	2.06	6.23	0.79
Food additives and flavourings	2.36	$ -0.52 =0.52$	-
Food contact materials	2.12	7.95	0.89
Fruits and vegetables	2.04	10.23	0.88
Herbs and spices	2.08	15.34	0.96
Honey and royal jelly	2.23	1.26	-
Ices and desserts	2.14	0.22	-
Meat and meat products (other than poultry)	2.06	5.24	0.72
Milk and milk products	2.06	$ -0.37 =0.37$	-
Natural mineral water	2.57	1.68	-
Non-alcoholic beverages	2.06	1.39	-
Nuts, nut products and seeds	2.09	3.96	0.67
Other food product / mixed	2.16	$ -0.21 =0.21$	-
Poultry meat and poultry meat products	2.10	2.05	-
Prepared dishes and snacks	2.14	0.88	-
Soups, broths, sauces and condiments	2.11	2.23	0.48
Water for human consumption (other)	3.18	2.10	-
Wine	2.18	$ -1.31 =1.31$	-

Source: own study

Table 2. The values of critical statistics $t_{0.05;n-2}$, the calculated statistics t and Pearson's correlation coefficients r for the hazards categories
 Tabela 2. Wartości statystyki krytycznej $t_{0.05;n-2}$, statystyki obliczonej t oraz współczynnika korelacji Pearsona r dla kategorii zagrożeń

Hazard category	$t_{0.05;n-2}$	$ t $	r
Adulteration / fraud	2.13	1.11	–
Allergens	2.14	2.37	0.53
Biocontaminants	2.07	1.98	–
Biotoxins (other)	2.04	-0.42 =0.42	–
Chemical contamination (other)	2.10	-0.88 =0.88	–
Composition	2.08	8.73	0.89
Feed additives	2.57	-1.97 =1.97	–
Food additives and flavourings	2.13	9.76	0.93
Foreign bodies	2.09	8.32	0.88
GMO / novel food	2.31	1.77	–
Heavy metals	2.06	6.52	0.80
Industrial contaminants	2.12	2.53	0.53
Labelling absent/incomplete/incorrect	2.23	-0.69 =0.69	–
Migration	2.57	2.05	–
Mycotoxins	2.08	6.39	0.81
Non-pathogenic micro-organisms	2.06	1.74	–
Not determined / other	2.11	1.26	–
Organoleptic aspects	2.10	3.01	0.58
Packaging defective / incorrect	2.09	-1.15 =1.15	–
Parasitic infestation	2.20	-0.63 =0.63	–
Pathogenic micro-organisms	2.04	5.94	0.72
Pesticide residues	2.07	4.30	0.67
Poor or insufficient controls	2.23	1.17	–
Radiation	2.26	8.05	0.94
Residues of veterinary medicinal products	2.12	2.02	–

Source: own study

The value of calculated statistics $t_{0.05;n-2}$, higher than the value of critical statistics indicated that there was a statistically significant relationship between examined variables X and Y , i.e. alert notifications in the RASFF to food from the non-EEA and EEA countries in 12 (out of 28) products categories and in 11 (out of 25) hazards categories. If the value of calculated statistics t was lower than the value of critical statistics $t_{0.05;n-2}$, a statistically significant relationship between examined variables did not occur (in 16 products categories and 14 hazards categories).

If the relationship occurred, the value of Pearson's r correlation coefficient indicated very high (0.9-1), high (0.7-0.9), moderate (0.5-0.7) and low (0.3-0.5) correlation - see [Crewson 2008].

In the case of products categories the very high correlation occurred in the category "Herbs and spices" (the value of Pearson's correlation coefficient was 0.98) and the high correlation occurred in the following categories: "Bivalve molluscs and products

thereof" (0.70), "Dietetic foods, food supplements, fortified foods" (0.86), "Fish and fish products" (0.79), "Food contact materials" (0.89), "Fruits and vegetables" (0.88) and "Meat and meat products (other than poultry)" (0.72). It is worth noting that in the case of product category "Food contact materials" since 2008, when began to notify the border rejection at the EEA border in the RASFF, there has been no further alert notifications in this category, both to food from non-EEA and EEA countries - see [European Commission 2014]. This shows the effectiveness of the actions within this category. The moderate correlation occurred in case of following products categories: "Cereals and bakery products" (0.61), "Cocoa and cocoa preparations, coffee and tea" (0.54), "Crustaceans and products thereof" (0.55), "Nuts, nut products and seeds" (0.67), while the low correlation occurred in the product category "Soups, broths, sauces and condiments" (0.48).

In case of hazards categories the very high correlation occurred in the category "Food

additives and flavourings" (0.93) and "Radiation" (0.94). It is worth noting that the hazard category "Food additives and flavourings" also occurs in the products categories where there was no correlation. However, there, the food additives and flavourings should be treated as a raw material for the food production, while here, in hazards categories, as a food contamination (above the acceptable level). The high correlation occurred in case of following hazards categories: "Composition" (0.89), "Foreign bodies" (0.88), "Heavy metals" (0.80), "Mycotoxins" (0.81) and "Pathogenic microorganisms" (0.72). While the moderate correlation was in following hazards categories: "Allergens" (0.53), "Industrial contaminants" (0.53), "Organoleptic aspects" (0.58) and "Pesticide residues" (0.67).

The subject of alert notifications in the RASFF to certain products categories or hazards categories is raised in the literature on food safety. These are mainly those categories in which notifications are reported most frequently, and in the greatest number.

First of all, it is worth noting that the high or moderate correlation occurred in all products categories that could be classified as seafood, i.e.: "Bivalve molluscs and products thereof", "Crustaceans and products thereof" and "Fish and fish products". Kleter et al. [2009] notes that in the period they studied (2003-2007), notified over 2000 alert and information notifications to seafood in the RASFF. Anacleto et al. [2015] noted also the occurrence of alert notifications in the RASFF to bivalve molluscs and products thereof. Broughton and Walker [2010] pointed out that within the RASFF were transmitted the alert notifications on the occurrence of industrial pollutions in aquaculture products imported from China. Therefore, already in 2004, the European Union and China initiated a project internships and workshops for Chinese inspectors on the RASFF. D'Amico et al. [2014] mentioned, however, that seafood from China has the largest percentage of rejections at the EU border. Jespersen [2014] drew attention to the alert notifications to the shrimp from Bangladesh, but also the pang of Vietnam, contaminated with antibiotics and pesticide residues. On the other hand, as

indicated the RASFF notifications in the recent years can be seen a significant reduction of antibiotics residues used in shrimp production in China, Vietnam and Thailand [Rico et al. 2013]. Kleter and Marvin [2009] also pointed to the presence of the chemical hazards in fish. Figueroa [2008] mentioned the alert notifications in the RASFF on cadmium (heavy metal) in fish products. He added that the rejection of such products causes severe losses for exporters from developing countries. They are related not only to the cost of the product itself, but also to the costs of its delivery. While Noël et al. [2011] mentioned the RASFF notifications regarding heavy metals to seafood imported into France and to domestic seafood. Amagliani et al. [2012] pointed out that in the RASFF notifications indicated the presence of Salmonella in fish, cephalopods, bivalves and crustaceans. They indirectly pointed to China, but also Thailand and Vietnam, as countries, which export the largest amount of seafood.

Kleter et al. [2009] drew attention to the presence of a large number of notifications (alerts and information) to spices. Elviss et al. [2009] gave examples of occurrence of Salmonella in herbs imported into the United Kingdom, Denmark and Norway. However, most often the presence of mycotoxins (aflatoxins in particular), for example, in 2012, was notified to fruit and vegetables as well as nuts, nut products and seeds. What is important, however, since 2008 (when border rejections at the EEA border were introduced) to 2012 declined the number of RASFF notifications concerning the presence of aflatoxins. However, in 2012 mycotoxins were the main group of hazards because of which were rejected imported products at the border - see [Marin et al. 2013]. The occurrence of mycotoxins in RASFF notifications also pointed Cheli et al. [2014] (2011) and Kleter et al. [2009] (in 2003-2007 mycotoxins was the second most common hazards category after chemical hazards). García-Cela et al. [2012] pointed out that in 2000-2010 in the RASFF were total over 7000 notifications (alert, information and border rejections) concerning mycotoxins. The largest number of notifications concerned nuts, nut products and seeds, especially pistachios. The authors pointed out the possibility of the appearance of mycotoxins in successive stages from the

collection by importing up to provide nuts to the consumer. Van Boxtael et al. [2013] pointed out, in turn, that the European Commission carries out the risk analysis, increasing the number of border controls, depending on the food origin. This includes e.g. Salmonella in basil imported from Thailand or pesticide residues on tomatoes originating in Turkey.

Orford et al. [2014] and Petroczi et al. [2011] mentioned the occurrence of alert notifications in RASFF in the food contact materials. Marvin et al. [2009] drew attention to the RASFF notifications on migration of heavy metals from dishes / utensils to food. This problem also noted Kleter et al. [2009], referring to dishes / utensils from China. He also pointed to the migration of heavy metals from food contact materials to food.

CONCLUSIONS

A correlation relationship of alert notifications in the RASFF to food from the non-EU and the EU countries was found in 12 (out of 28) products categories and in 11 (out of 25) hazards categories. The values of Pearson's *r* correlation coefficient indicated a correlation from very high, through high, moderate to low.

The occurrence of very high correlation was stated in the products category: "Herbs and spices" (0.98), and a high correlation in the following categories: "Bivalve molluscs and products thereof" (0.70), "Dietetic foods, dietary supplements, fortified foods" (0.86), "Fish and fish products" (0.79), "Food contact materials" (0.89), "Fruits and vegetables" (0.88) and "Meat and meat products (other than poultry)" (0.72). Whereas in the case of hazards categories the very high correlation occurred in the categories: "Food additives and flavourings" (0.93) and "Radiation" (0.94) and high correlation in the case of: "Composition" (0.89), "Foreign bodies" (0.88), "Heavy metals" (0.80), "Mycotoxin" (0.81) and "Pathogenic microorganisms" (0.72).

The results show the need to pay by the EEA border control authorities the particular

attention to seafood, herbs and spices and fruits which are imported and heavy metals, pathogenic microorganisms and mycotoxins which could be present in them. These products and hazards categories are also most frequently highlighted in the literature. First of all, the scope of border controls should be increased or extended. In addition, measures should be taken in order to shorten the supply chain, both in terms of time and the number of intermediate points. Can also draw the attention of consumers for these products, which are produced mainly in the EEA (not imported). Consumers not only consumed safer food, but also indirectly affected the development of the EU economy.

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ANALIZA KORELACJI POWIADOMIEŃ ALARMOWYCH W SYSTEMIE RASFF WOBEC ŻYWNOCİ Z KRAJÓW SPOZA EOG I Z KRAJÓW EOG

STRESZCZENIE. Wstęp: System RASFF (Rapid Alert System for Food and Feed), czyli System Wczesnego Ostrzegania o Niebezpiecznej Żywności i Paszach służy do szybkiego wzajemnego informowania się krajów członkowskich Europejskiego Obszaru Gospodarczego (EOG) o zagrożeniach w żywności. Podobny przebieg linii trendu powiadomień alarmowych w systemie RASFF w czasie wobec żywności z krajów spoza EOG i z krajów EOG, a także bardzo wysoka wartość współczynnika korelacji Pearsona r (0,96) wskazały na współzależność powiadomień alarmowych z tych dwóch grup krajów. W związku z tym celem artykułu było zbadanie siły korelacji w ramach poszczególnych kategorii produktów i kategorii zagrożeń.

Metody: Dane do badań pochodziły z bazy danych systemu RASFF z lat 1979-2013, obejmując 8175 powiadomień alarmowych, w tym 2540 powiadomień wobec żywności z krajów spoza EOG i 5635 powiadomień wobec żywności z krajów EOG. W ramach każdej kategorii produktów i kategorii zagrożeń badano, czy istniała korelacja (tzn. wartość statystyki obliczonej t przewyższyła wartość statystyki krytycznej $t_{0,05;n-2}$), a następnie obliczano wartość współczynnika korelacji Pearsona r .

Wyniki: Wartość współczynnika korelacji Pearsona r wskazała na występowanie bardzo wysokiej korelacji w kategorii produktów "Zioła i przyprawy korzenne" (0,98), a wysokiej korelacji w następujących kategoriach: "Małże i produkty pochodne" (0,70), "Żywność dietetyczna, suplementy diety, żywność wzbogacona" (0,86), "Ryby i produkty rybne" (0,79), "Materiały do kontaktu żywnością" (0,89), "Owoce i warzywa" (0,88) oraz "Mięso i produkty mięsne (z wyjątkiem drobiu)" (0,72). Natomiast w przypadku kategorii zagrożeń korelacja bardzo wysoka wystąpiła w kategorii "Dodatki do żywności i środki aromatyzujące" (0,93) oraz "Promieniowanie" (0,94), a korelacja wysoka w przypadku "Składu" (0,89), "Ciał obcych" (0,88), "Metali ciężkich" (0,80), "Mykotoksyn" (0,81) oraz "Mikroorganizmów patogennych" (0,72).

Wnioski: Wyniki badań wskazały na konieczność zwrócenia szczególnej uwagi przez organy kontroli granicznej EOG na m.in. importowaną żywność pochodzenia morskiego, zioła i przyprawy i owoce oraz obecne w nich metale ciężkie, mikroorganizmy patogenne i mykotoksyny. Należałoby także skrócić łańcuch dostaw i/lub ograniczyć import niektórych surowców i produktów, kierując uwagę konsumentów na żywność produkowaną przede wszystkim na terenie EOG.

Słowa kluczowe: EOG, system RASFF, powiadomienia alarmowe, kategorie produktów, kategorie zagrożeń, analiza korelacji

DIE KORRELATIONSANALYSE VON WARNMELDUNGEN IM RASFF-SYSTEM FÜR LEBENSMITTEL AUS DEN EWR- UND NICHT-EWR-LÄNDERN

ZUSAMMENFASSUNG. Einleitung: Das RASFF-System (Schnellwarnsystem für Lebens- und Futtermittel) dient dem Informationsaustausch zwischen den EWR-Mitgliedstaaten über potentielle Gesundheitsrisiken bei Lebens- und Futtermitteln. Ein zeitlich ähnlicher Ablauf von Warnmeldungen im RASFF-System in Bezug auf die Lebensmittel aus den EWR- und Nicht-EWR-Staaten sowie ein sehr hoher Wert des Pearson-Korrelationskoeffizienten r (0,96) deuteten auf eine Korrelation der Warnmeldungen der beiden Staatsgruppen hin. Im Zusammenhang damit war das Ziel des Artikels, die Korrelationsstärke im Rahmen der verschiedenen Produkt- und Risikokategorien zu untersuchen.

Methoden: Die Daten für die Forschungsstudie kamen von der RASFF-Datenbank aus den Jahren 1979-2013, die 8175 Warnmeldungen, einschließlich 2.540 Meldungen für die Lebensmittel aus den Nicht-EWR-Ländern und 5.635 Meldungen für die Lebensmittel aus den EWR-Ländern, umfassten. Innerhalb jeder Produkt- und Risikokategorie wurde untersucht, ob eine Korrelation gegeben ist (d.h. ob der berechnete t -Wert höher als der kritische $t_{0,05;n-2}$ ist), und danach der Pearson'sche Korrelationskoeffizient r berechnet.

Ergebnisse: Der Wert des Pearson-Korrelationskoeffizienten r deutete auf eine sehr hohe Korrelation in der Produktkategorie "Kräuter und Gewürze" (0,98) und eine hohe Korrelation in folgenden Kategorien: "Zweischalige Weichtiere und daraus entstandene Produkte" (0,70), "Diätetische Lebensmittel, Nahrungsergänzungsmittel und angereicherte Lebensmittel" (0,86), "Fisch und Fischereiprodukte" (0,79), "Gegenstände und Materialien für Lebensmittelkontakt" (0,89), "Obst und Gemüse" (0,88) und "Fleisch und Fleischprodukte (außer Geflügel)" (0,72), hin. In der Risikokategorie hingegen wurde eine sehr hohe Korrelation in der Kategorie "Lebensmittelzusatzstoffe und Aromen" (0,93) und "Strahlung" (0,94) und eine hohe Korrelation im Fall der Kategorien: "Komposition" (0,89), "Fremdkörper" (0,88), "Schwermetalle" (0,80), "Mykotoxine" (0,81) und "Pathogene Mikroorganismen" (0,72) festgestellt.

Fazit: Die Untersuchungsergebnisse zeigten, dass die besondere Aufmerksamkeit der Grenzschutzbehörden u.a. den importierten Meeresfrüchten, Kräutern, Gewürzen und Obst sowie den in diesen Produkten enthaltenen Schwermetallen, pathogenen Mikroorganismen und Mykotoxinen gewidmet werden soll. Es sollte auch die Versorgungskette gekürzt und /oder die Einfuhr bestimmter Rohstoffe und Produkte eingeschränkt sowie die Aufmerksamkeit der Verbraucher auf die vor allen in den EWR-Staaten hergestellten Lebensmittel gerichtet werden.

Codewörter: EWR (Europäischer Wirtschaftsraum), RASFF-System, Warnmeldungen, Produktkategorien, Risikokategorien, Korrelationsanalyse

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