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Analysis of RASFF notifications for mycotoxins in 2020–2022

Selime S. Ibragimova[1], Olga V. Pruntova[2], Natalya B. Shadrova[2], Tatyana V. Zhbanova[2]

[1] Crimean Testing Laboratory of Federal Centre for Animal Health, 21a Shosseynaya str., Simferopol 295494, Republic of Crimea, Russia

[2] Federal Centre for Animal Health, Yur'evets, Vladimir 600901, Russia

ABSTRACT

Introduction. Mycotoxins are secondary metabolites of various fungi. The contamination with mycotoxins is subject to control. Pursuant to the accepted classification in accordance with Council Directive 96/23/EC they belong to group B3: "Other substances and environmental contaminants". Information on detected exceedances of maximum permitted levels in feed and food is notified to the RASFF and ACN information systems, which operate across the European Union.

Objective. Analysis of RASFF and ACN notifications for mycotoxins in food and feed in 2020–2022.

Materials and methods. 1,335 publications on exceedances of maximum permitted levels of mycotoxins (aflatoxins, ochratoxin A, deoxynivalenol, zearalenone and patulin) in food and feed have been analysed.

Results. Breakdown of mycotoxin notifications during the analyzed period was as follows: aflatoxins – 87.1%, ochratoxin A – 11.6%, patulin – 0.6%, deoxynivalenol – 0.5%, zearalenone – 0.2%. Aflatoxin contaminations were most often reported in groundnuts (764 notifications), ochratoxin A in dried figs (43 notifications), patulin in apple juice (6 notifications), zearalenone and deoxynivalenol in cereals and bakery products. Feedstuffs and feed ingredients were found to be contaminated only with aflatoxins (33 notifications), and 66.7% of notifications accounted for groundnuts intended for feeding. An analysis of mycotoxin contamination dynamics demonstrated that there was an increase in the number of notifications in 2021 and 2022.

Conclusion. According to RASFF and ACN notifications, mycotoxins were the third most notified hazard category in 2020–2022. Elevated mycotoxin concentrations were detected exclusively in plant products.

Keywords: mycotoxins, aflatoxins, ochratoxin, patulin, deoxynivalenol, zearalenone, RASFF system, European Union, agricultural products, animal products, feed, contamination, exceeding maximum levels

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For correspondence: Selime S. Ibragimova, Leading Veterinarian, Microbiological Testing Unit, Crimean Testing Laboratory of Federal Center for Animal Health, 21a Shosseynaya str., Simferopol 295494, Republic of Crimea, Russia, *ibragimova@arriah.ru*

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Анализ выявлений микотоксинов по данным информационной системы RASFF за период с 2020 по 2022 г.

С. С. Ибрагимова[1], О. В. Прунтова[2], Н. Б. Шадрова[2], Т. В. Жбанова[2]

[1] Крымская испытательная лаборатория ФГБУ «Федеральный центр охраны здоровья животных» (КрымИЛ ФГБУ «ВНИИЗЖ»), ул. Шоссейная, 21а, г. Симферополь, 295494, Республика Крым, Россия

[2] ФГБУ «Федеральный центр охраны здоровья животных» (ФГБУ «ВНИИЗЖ»), мкр. Юрьевец, г. Владимир, 600901, Россия

РЕЗЮМЕ

Введение. Микотоксины – вторичные метаболиты плесневых грибов, являются контаминантами, подлежат контролю. Согласно принятой классификации, по требованиям Директивы Совета Европейского союза 96/23ЕС, относятся к группе В3: «Прочие вещества и загрязнители окружающей среды». Информация о выявлении превышения предельно допустимых концентраций в кормах и пищевых продуктах вносится в информационную систему RASFF и ACN, функционирующую на территории стран Европейского союза.

Цель исследования. Анализ сведений о контаминации микотоксинами пищевой продукции и кормов за период с 2020 по 2022 г., зарегистрированных в информационной системе RASFF и ACN.

Материалы и методы. Объектом анализа были 1335 сообщений о превышении предельно допустимых концентраций микотоксинов (афлатоксинов, охратоксина А, дезоксиниваленола, зеараленона и патулина) в пищевых продуктах и кормах.

Результаты. Распределение случаев выявления микотоксинов в анализируемый период: афлатоксины – 87,1%, охратоксин А – 11,6%, патулин – 0,6%, дезоксиниваленол – 0,5%, зеараленон – 0,2%. Превышение предельно допустимой концентрации афлатоксинов чаще всего обнаруживали в арахисе (764 сообщения), охратоксина А – в сушеном инжире (43 сообщения), патулина – в яблочном соке (6 сообщений), зеараленона и дезоксиниваленола – в продукции из категории «крупы и хлебобулочные изделия». В кормах и кормовом сырье были выявлены несоответствия по содержанию исключительно афлатоксинов (33 сообщения), которые в 66,7% случаев обнаруживали в арахисе, предназначенном для кормовых целей. Анализ динамики контаминации продукции микотоксинами показал, что в 2021 и 2022 гг. наблюдали рост количества регистрируемых сообщений об их детекции.

Заключение. Согласно отчетам RASFF и ACN за 2020–2022 гг., микотоксины представляли третью по распространенности категорию опасности. Нарушение законодательства в части превышения предельно допустимых концентраций микотоксинов выявлено исключительно в продукции растительного происхождения.

Ключевые слова: микотоксины, афлатоксины, охратоксин, патулин, дезоксиниваленол, зеараленон, система RASFF, Европейский союз, сельскохозяйственные продукты, продукты животного происхождения, корма, контаминация, превышение предельно допустимых концентраций

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Для корреспонденции: Ибрагимова Селиме Серверовна, ведущий ветеринарный врач отдела микробиологических исследований КрымИЛ ФГБУ «ВНИИЗЖ», ул. Шоссейная, 21а, г. Симферополь, 295494, Республика Крым, Россия, *ibragimova@arriah.ru*

INTRODUCTION

Currently, more than 400 mycotoxin types are known which are produced by fungi belonging to *Aspergillus*, *Penicillium*, *Fusarium*, *Claviceps*, *Neotyphodium*, *Myrothecium*, *Stachybotrys*, *Trichoderma*, *Trichothecium* genera, etc. [1, 2, 3, 4, 5].

According to domestic and foreign publications, feed and plant products are highly contaminated with micromycetes (up to 80–100%), including toxin-producing micromycetes (up to 40–60%), and in 21% of cases mycotoxins are produced in concentrations dangerous to animal and human health. The problem of feed and food contamination by micromycetes of mold fungi and their metabolites is prevalent and has no geographical boundaries. The contamination level depends on environmental conditions (temperature and humidity), compliance with the rules of agricultural technology, plant resistance to phytopathogens, etc. [6, 7, 8, 9, 10, 11].

Feeding animals with mycotoxin-contaminated feeds causes numerous non-infectious diseases, known as food-borne mycotoxicosis. Clinical signs and symptoms depend on a variety of factors: the mycotoxin type, the amount and duration of exposure, general health condition and immune status of the animal. Mycotoxicoses are divided by the type of a toxin or fungus they are caused by: fusariotoxicosis, aflatoxicosis, ochratoxicosis, patulinotoxicosis, stachybotriotoxicosis, etc. Depending on livestock and poultry species, age, and physical condition, different sensitivity to the action of various mycotoxins is reported. For example, piglets under 3 months of age, pregnant sows, calves, fattening pigs, adult cattle and sheep are the most susceptible to aflatoxins. Turkeys, ducklings, and goslings are highly sensitive among poultry. Pigs and poultry are susceptible to ochratoxins. Horses and cattle are sensitive to stachyobothriotoxin, horses, pigs; poultry are susceptible to fusariotoxins and fumonisins, pigs and cattle to patulin [1, 12, 13, 14, 15, 16].

In the Russian Federation, the ten-year monitoring data obtained from annual mycotoxicological tests of complete feeds for pigs and poultry, provided by farms and processing plants located in the Northwestern, Central, Southern, Volga and Ural Federal districts, reveal the following toxins: T-2 mycotoxin, diacetoxyscirpenol, deoxynivalenol, zearalenone, fumonisins B, alternariol, ochratoxin A, citrinin, aflatoxin B_1, sterigmatocystin, cyclopiazonic acid, mycophenolic acid, ergot alkaloids and emodin. The results obtained confirmed the relevance of mycotoxin contamination systematic control [17].

According to BIOMIN GmbH (Austria) scientific data obtained by testing of 6,844 samples of agricultural products, the most frequent mycotoxins in the world are deoxynivalenol (66%), fumonisins (56%) and zearalenone (53%) [18].

According to literature sources, among several hundred known mycotoxins, aflatoxins, T-2 mycotoxin, ochratoxin A, patulin, fumonisins, zearalenone and deoxynivalenol are the most common and dangerous to livestock health and performance [19, 20, 21, 22].

Aflatoxins, when ingested, inhaled or adsorbed through the skin, have hepatotoxic, teratogenic and cytotoxic effects. The toxic effect is enhanced by the presence of T-2 toxin or ochratoxin in feed and relatively low levels of crude protein, methionine, and vitamin D_3. Out of the ochratoxins, ochratoxin A is the most dangerous one, which inhibits protein synthesis and disrupts carbohydrate metabolism by inhibiting the activity of a specific enzyme that initiates protein synthesis [23, 24, 25, 26, 27, 28].

Fusariotoxins commonly encountered in the world are deoxynivalenol (DON, vomitoxin) and zearalenone. DON is most often detected in wheat, less often in corn, barley, rye, oats and grain products. Zearalenone differs from other mycotoxins as it has hormone-like effect and is less toxic, not leading to death. It is an uterotrophic and estrogenic substance that induces hyperestrogenism in pigs, infertility and stunted growth in cattle and poultry [29, 30, 31, 32, 33].

Patulin is usually found in rotten fruits, berries and vegetables; it has mutagenic, neurotoxic, nephrotoxic and immunotoxic effects, and can cause gastrointestinal injuries [1, 34].

Geographically, aflatoxins are most widespread in regions with a tropical climate (Africa and Southeast Asia); ochratoxins are found in regions with a cool, humid climate (Northern Europe); fusariotoxins and zearalenone are widespread everywhere, including in the Russian Federation [1, 13].

According to the Food and Agriculture Organization of the United Nations (FAO), up to 30% of food and fodder crops are contaminated with mycotoxins. Reports from domestic and foreign information sources confirm that mycotoxicosis significantly impairs the livestock performance and reproduction, bringing significant economic losses for livestock farming. In addition, toxic substances produced by mold fungi pose a serious danger to the health of consumers of agricultural products. In this regard, the issues related to the detection of mycotoxins in agricultural and food products are relevant [1, 6, 33, 34, 35, 36].

In the Russian Federation, the maximum levels of mycotoxins in agricultural and food products are regulated by the Technical Regulations of the Customs Union, namely: TR CU 015/2011 "On grain safety", TR CU 021/2011 "On food safety", TR CU 033/2013 "On the safety of milk and dairy products". In addition, mycotoxins have been included in the list of parameters to be tested for monitoring purposes since 2007. The monitoring is organized and conducted annually by the Federal Service for Veterinary and Phytosanitary Surveillance (Rosselkhoznadzor) [37].

The novelty of this work consists in the analysis and interpretation of information on mycotoxin contamination of food and feed in European countries.

The aim of the study is to analyze information on mycotoxin contamination of food and feed in the European Union (EU) countries based on reports from the RASFF (Rapid Alert System for Food and Feed) for 2020–2022.

MATERIALS AND METHODS

The RASFF notifications on the detection of mycotoxins (aflatoxins, ochratoxin A, deoxynivalenol, zearalenone and patulin) in food and feed for 2020–2022 became the object of analysis.

RESULTS AND DISCUSSION

Rapid Alert System for Food and Feed (RASFF). The common legal framework regarding safety of agricultural products, food raw materials and feed based on Regulations No. 178/2002 and No. 882/2004 is valid in the EU [38, 39].

Regulation No. 178/2002 lays down general principles and requirements for the quality and safety of agricultural products and food raw materials, covering all stages of production and processing. In addition, this act establishes and defines the powers of the European Food Safety Agency (EFSA) and provides the legal basis for the RASFF in the EU. Regulation No. 882/2004 establishes the general principles of official control performed to ensure compliance with feed and food law [40, 41, 42, 43].

The RASFF is a key tool for the rapid exchange of information on detections of contaminants in food or feed posing risks for human and animal health. This system was created in 1979 under Food Safety Directive. The feeds were not officially covered by the system. Since January 28, 2002 Article 50 of Regulation No. 178/2002 of the European Parliament and the Council has been the legal basis for the RASFF. The Article establishes the general principles and requirements of the EU food legislation, covering all stages of food production and processing within the food chain "from stable to table", including feed and feed raw materials [39, 40, 44].

In 2020, hazards were established to be included into notifications categorized by feed products, origin countries, and notifying countries. From March 2021 RASFF, together with the Administrative Assistance and Cooperation Network (AAC) and the Agri-Food Fraud Network (FFN) have been merged into the Alert and Cooperation Network (ACN). The Network was established by Commission Implementing Regulation (EU) 2019/1715 which sets up and manages a computerized information management system for official controls (IMSOC). The ACN notification system includes three networks (RASFF, AAC and FFN), ensuring an unhindered exchange of information between the competent authorities of the Member States and facilitating cooperation between them [45].

The RASFF notifications concern product controls at the EU's external borders, at entry points or border inspection posts, and inspections by competent authorities or food poisoning incidents. Contact points have been set up in all RASFF Member States and the European Commission, between which information is exchanged [38, 45, 46, 47].

The RASFF member notifies of the existence of a serious, direct or indirect, risk to public health linked to food or feed. After receiving the notification, other members can trace whether these products are available on their market. Next, these members report back on what they have found and what measures they have taken. The notifications also concern controls at European Economic Area borders, at points of entry or border inspection posts when a consignment was not accepted for import [45, 46, 47].

When a problem is detected in the internal market, it is the task of the national food and feed authorities to take action. This includes any action necessary to immediately address the risk but also to prevent a similar risk reoccurring. A whole range of actions are carried out and reported back through RASFF: withdrawal or recall of the products and their possible destruction, information to the public, re-dispatch to origin etc. [45, 46].

Mycotoxin hazards (aflatoxins, ochratoxin A, patulin, DON, zearalenone) notified by the EU countries in 2020–2022. According to the RASFF and ACN annual reports, mycotoxins rank third behind pesticide residues and *Salmonella* among hazards [45, 46, 47].

An analysis of mycotoxin contamination dynamics, focusing on concentrations exceeding maximum levels (MLs) in RASFF notifications, revealed a clear upward trend in 2021–2022. In 2021, reported mycotoxin cases increased by 6% compared to 2020, followed by a further 10.5% rise in 2022. The 2020 RASFF Annual Report documented a 23% decline in hazard detections compared to 2019, which authorities attributed primarily to COVID-19 pandemic disruptions [45, 46, 47].

According to RASFF reports for 2020 and ACN reports for 2021 and 2022, 1,335 notifications on exceeding MLs of mycotoxins in food and feed were reported. In 2020, 400 notifications were registered, 450 notifications were

Table
Mycotoxin detection dynamics in 2020–2022 according to RASFF and ACN

Mycotoxin	2020		2021		2022		Total number of notifications
	No.	%*	No.	%*	No.	%*	
Aflatoxins	343	87.0	387	88.8	413	85.7	1,143
Ochratoxin A	41	10.4	46	10.5	65	13.5	152
DON	6	1.5	1	0.2	0	0	7
Zearalenone	1	0.3	0	0	1	0.2	2
Patulin	3	0.8	2	0.5	3	0.6	8
Total	394	100	436	100	482	100	1,312

* % of the total number of detections for the year.

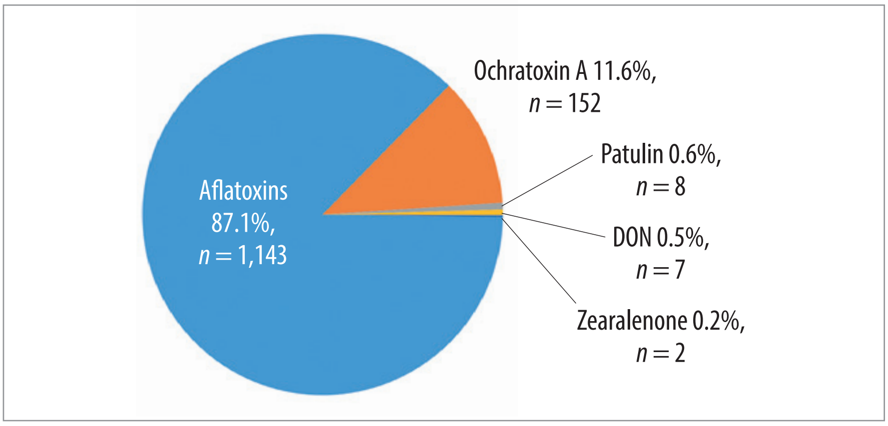

Fig. 1. Types of mycotoxins and rates of their detection in plant product samples in 2020–2022

made in 2021, and 485 in 2022. Of 1,335 reports, 1,312 contain information on mycotoxin findings covered by this paper: aflatoxins, ochratoxin A, patulin, DON and zearalenone. Mycotoxin detection dynamics in 2020–2022 according to RASFF and ACN is given in the table below.

Of the 1,312 notifications on mycotoxin findings, 1,007 were reported during border control, 162 during official market control, 142 as a result of internal inspections, and one notification was generated in the RASFF system following a consumer poisoning incident due to ochratoxin A exceeding levels [48].

It was found that during this period, aflatoxins (87.1%), ochratoxin A (11.6%), patulin (0.6%), DON (0.5%), zearalenone (0.2%) were most frequently notified mycotoxins in the RASFF system. Data are shown in Figure 1. It should be noted that only plant-based commodities contained mycotoxin concentrations above maximum limits.

Aflatoxin findings (according to RASFF data for 2020–2022). Of 1,143 RASFF notifications, 97.1% were for aflatoxins detected in food products and 2.9% in feed and feed materials.

The exceeding MLs of aflatoxins in food are evidenced by 1,110 notifications in the following product categories: "Nuts, nut products and seeds", "Fruits and vegetables", "Cereals and bakery products", "Herbs and spices", "Other food product / mixed", "Confectionery", "Cocoa and cocoa preparations, coffee and tea" and "Ice cream and desserts".

Notifications in the category "Nuts, nut products and seeds" category were made in 67.9% of cases (776 notifications); 52.0% (403) of them were made for peanuts; 27.6% (214) for pistachios; 9.1% (71) for hazelnuts; 3.6% (28) for almonds; 2.1% (16) for peanut butter; 1.2% (9) for watermelon seeds; 1.0% (8) for melon seeds; 0.5% (4 for each) notifications were reported for Brazil nuts and sesame seeds; 0.4% (3) for almond flour; 0.3% (2 for each) notifications for ogbono seeds, apricot kernels, hazelnut paste, cashews; 0.1% (1 for each) for sunflower, lotus seeds, nut mix, chia seeds, pistachio flour, almond nougat, peanut paste and nut crackers.

163 notifications (14.3%) were reported in "Fruits and vegetables" category. Most findings were reported for dried figs – 94.5% (154), as well as for dried dates – 3.1% (5), mulberry –1.8% (3), date syrup – 0.6% (1).

7.4% of notifications (85) were made in "Cereals and bakery products" category, of which 75.0% (64) were findings in rice; 4.7% (4) in corn, 3.5% (3) in wheat flour, 2.4% (2 for each) in buckwheat, millet seeds, dry soy product, a mixture of millet, corn and baobab juice, 1.2% (1 for each) in wheat, rice flour, corn flour, spelt flour, almond flour and buckwheat husk flour.

74 (6.5%) notifications were made to the RASFF about aflatoxins in "Herbs and spices" category products within the mentioned period. Among them 21 notifications (28.4%) were on hazards in spice mixture; 16 (21.6%) in nutmeg, 13 (17.6%) in whole dried chili peppers; 10 (13.5%) in crushed chili peppers; 5 (6.8%) in turmeric, 4 (5.4%) in ground ginger, 3 (4.0%) in curry powder; 2 (2.7%) in black pepper.

In "Other food product / mixed" category, which included hazelnut paste, date syrup, shelled peanuts, rice flour, paste for filling and ice cream sprinkles, only 5 notifications (0.4%) were made; one for each type of product. Only 5 notifications (0.4%) were reported in the "Confectionery" category, of which 3 (60.0%) were for peanut candies; 1 (20.0% each) for peanut halva and pistachio halva. In the "Cocoa, cocoa preparations, coffee and tea" (in cocoa powder) and "Ice cream and desserts" (in peanut paste for ice cream) categories, 1 notification was registered (0.1% for each).

33 notifications were made on exceeded MLs of aflatoxins in feed and feed materials in the following categories: "Source material / feed" – 25 notifications (75.8%); "Nuts, nut products and seeds" (peanuts) – 6 (18.2%) notifications; one notification was made in "Feed materials" (non-compliances found in corn gluten) and "Pet food" categories (3.0% each). In the "Source material / feed" category: 16 notifications (64.0%) were made for peanuts, 2 (8.0% each) for millet and sunflower seeds, 1 notification for each of (4.0% each) in rice flour, rice bran and protein, corn gluten and cottonseed flour.

Ochratoxin A findings (according to RASFF data for 2020–2022). During the study period, 152 notifications of ochratoxin A non-compliant concentration were made.

In products from "Fruits and vegetables" category, 73 non-compliances (48.0%) were detected, of which 43 (58.9%) were in dried figs; 20 (27.4%) in raisins, 3 (4.1%) in mulberries and 3 in dates, 1 (1.4%) in date syrup, fig bread with almonds, canned plums and apricot kernels.

In the "Cereals and bakery products" category, 36 notifications were made in 2020–2022, which accounted for 23.7% of the total number of notifications on ochratoxin A. Among them, 44.4% (16 notifications) were on exceeding MLs in rice, 11.1% (4 notifications) in wheat flour, notifications were made for wheat, oats, rye bread, rye flakes, rye flour, bread rolls, muesli, dry soy product, quinoa groats, corn flour, whole-grain rye pasta, oat flakes, baby food, fruit and oat bars, red quinoa and rolls (one for each).

27 notifications (17.7%) were made in the "Herbs and spices" category, 11 (40.7%) on exceeding MLs in nutmeg, 10 (37.1%) in ground pepper, 3 (11.1%) in crushed licorice root, 2 (7.4%) in chili seasoning, 1 (3.7%) in dietary supplements.

5 notifications (3.3%) were made in the "Nuts, nut products and seeds" category: 4 (80%) in pistachios and 1 (20%) in watermelon seeds.

There were 4 notifications (2.6%) on ochratoxin A in date syrup ("Other food product / mixed" category), and 4 notifications (2.6%) on exceeding MLs in instant coffee (3) and in a mixture of roasted and ground coffee (1) in the "Cocoa, cocoa preparations, coffee and tea" category.

During the studied period, the RASFF received notifications about exceeding MLs of ochratoxin A in astragalus extract powder ("Dietetic foods, food supplements and fortified foods"), Rossa wine ("Wine" category) and fruit bars ("Prepared dishes and snacks"), one for each (0.7%).

Deoxynivalenol and zearalenone findings (according to RASFF data for 2020–2022). Violations of European MLs for DON were reported only in "Cereals and bakery products" category: 7 notifications were sent during the period under study. This mycotoxin was found in wheat and corn grains (2 notifications, 28.6% each), wheat flour, instant noodles and breadcrumbs (1 notification, 14.3% each). Most DON detections were made in 2020 (6 RASFF notifications were registered), and 1 notification was received in 2021. In 2020, one wheat sample, in addition to DON levels above MLs, zearalenone concentration was also too high. The second case of zearalenone detection was reported in 2022; this mycotoxin was detected in rice crackers.

Patulin findings (according to RASFF data for 2020–2022). During the study period, 8 notifications were received about non-compliant MLs of patulin in two RASFF categories: "Fruits and vegetables" (37.5%) and "Non-alcoholic beverages" (62.5%). In 75.0% of cases (6 notifications), this mycotoxin was detected in apple juice, 12.5% (1 notification for each) for apple sauce and natural apple-cherry juice.

Analysis of the distribution of identified mycotoxins by categories of plant products and feeds according to the RASFF classification. It should be noted that exceeding MLs of several types of mycotoxins have been reported in various product categories. Thus, in products of "Cereals and bakery products" category, exceeding MLs of four mycotoxins were detected; in "Fruits and vegetables" category, three mycotoxins were identified; in products from the "Nuts, nut products and seeds", "Herbs and spices", "Other food product / mixed" and "Cocoa, cocoa preparations, coffee and tea" categories two mycotoxins were detected. The mycotoxin distribution (aflatoxins, ochratoxin A, DON, zearalenone, patulin) by product category is demonstrated in Figure 2.

The MLs of aflatoxins (85 notifications; 65.4%), ochratoxin A (36 notifications; 27.7%), DON (7 notifications; 5.4%) and zearalenone (2 notifications; 1.5%) were reported in products from the "Cereals and bakery products" category. Moreover, in 2022, there was more than double increase in the number of reports of identified non-compliant aflatoxin levels in this category.

In the "Fruits and vegetables" category, there were notifications about levels of 3 types of mycotoxins above MLs: aflatoxins – 181 notifications (70.4%), ochratoxin A – 173 notifications (28.4%) and patulin – 3 notifications (1.2%).

Non-compliant levels of aflatoxins (758 (99.3%) and 74 (73.3%) notifications, respectively) and ochratoxin A (5 (0.7%) and 27 (26.7%) notifications, respectively) were reported in "Nuts, nut products and seeds" and "Herbs and spices" categories.

During the period under review, there were 5 notifications on aflatoxins and 4 notifications on ochratoxin A in products from "Other food product / mixed" category. In 2021, 4 notifications were reported to the RASFF about exceeding MLs of ochratoxin A and aflatoxins in "Cocoa, cocoa preparations, coffee and tea" products.

In categories such as "Confectionery", "Prepared dishes and snacks", "Dietetic foods, dietary supplements", "Ice cream and desserts", "Wine" and "Soft drinks", only one of the mycotoxins was above the established MLs.

In products intended for feed purposes of "Pet food", "Feed materials" and "Nuts, nut products and seeds", categories exceeding MLs of aflatoxins were found.

During the analytical study, co-contamination with several mycotoxins was noted in 16 cases, co-contamination with aflatoxins and ochratoxin A was reported in 14 notifications, co-contamination with zearalenone and DON, as well as with zearalenone and aflatoxins were also notified (1 notification for each case).

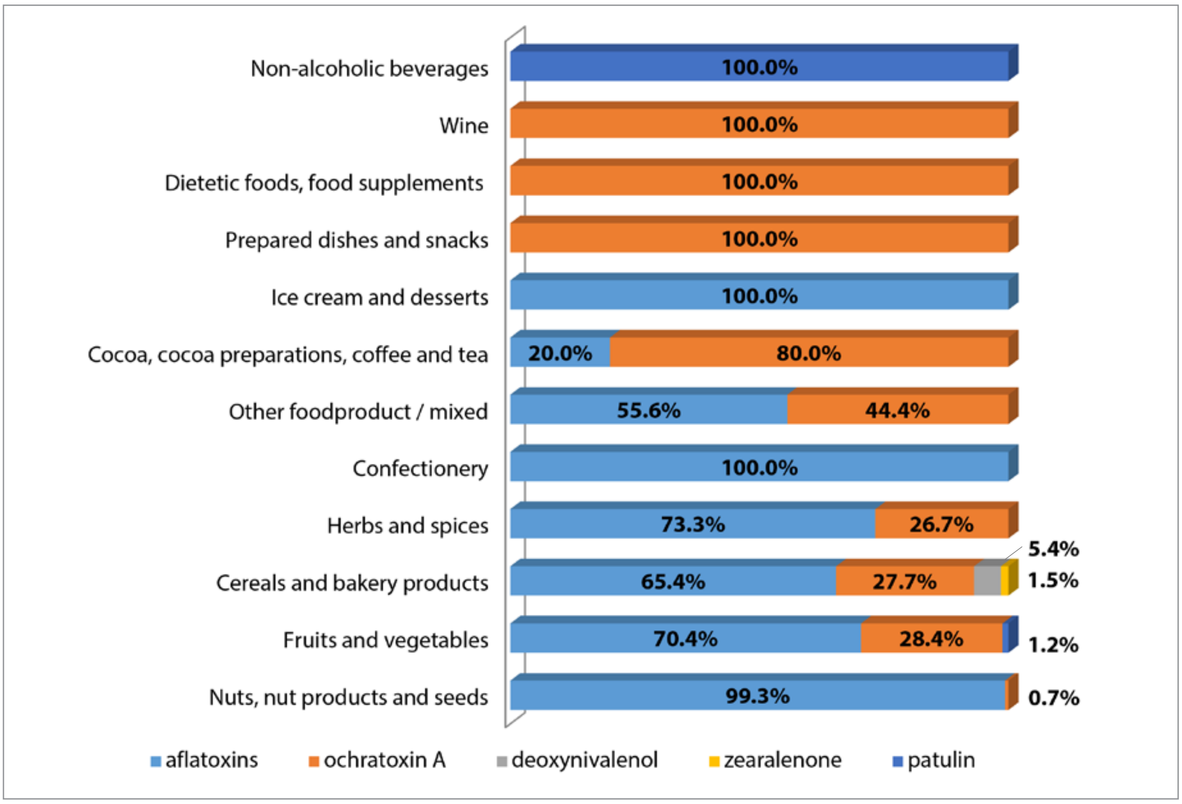

Fig. 2. Percentage ratio of detected mycotoxins in different plant product categories (according to RASFF for 2020–2022)

Based on the information provided in the RASFF notifications for 2020, 2021 and 2022, an increasing trend in the number of contaminations of feed and plant products with aflatoxins and ochratoxin A was noted. There were only a few notifications regarding the exceeding MLs of mycotoxins such as DON, zearalenone and patulin (Table), and they are insufficient to establish reliable trends in contamination of plant products and feed. At the same time, the findings confirm that this issue is prevalent, warranting systematic monitoring and control measures, as well as a thorough risk assessment of mycotoxin contamination in feed and plant-derived commodities.

According to literature data, DON, T-2 toxin, zearalenone and aflatoxins are most often detected in the Russian Federation. An analysis of contamination of food grain harvested in 2020 showed that 10% of the samples are co-contaminated with two or more mycotoxins. The most common contaminants of grain were tentoxin, DON, and cyclopiazonic acid, while those of corn were fumonisins B_1 and B_2. Ochratoxin A, aflatoxins, zearalenone, T-2 and HT-2 toxins, citrinin, sterigmatocystin, ochratoxin B, alternariol and its methyl ester, altenuene, and mycophenolic acid were also detected [49].

Mycotoxins exhibit organism-specific pathological effects, combining high toxicity, bioaccumulation potential, and diverse impacts – including embryotoxicity, teratogenicity, mutagenicity, carcinogenicity, immunosuppression, and cytotoxic, hepatotoxic, neurotoxic, dermatotoxic, and nephrotoxic effects. Mycotoxins disrupt protein synthesis, induce lymphatic tissue hypoplasia and bone marrow alterations, impair protein/lipid/mineral metabolism, exacerbate allergic responses, and cause hepatic, renal, and reproductive system damage [1, 12, 50].

For EU countries, the MLs of mycotoxins in food and agricultural products are established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The Committee consists of independent international experts who, based on the results of scientific research, issue recommendations on MLs, on measures to prevent and reduce contamination, laboratory methods for concentration measurement, etc. JECFA publications are regarded as international reference documents underlying international and regional standard development.

CONCLUSION

According to RASFF annual reports for 2020–2022, there were 1,312 notifications on exceeding MLs of mycotoxins. It was found that aflatoxins were the most frequently reported contaminants during the period under review (87.1%), with ochratoxin A ranking second (11.6%). Levels of patulin (0.6%), DON (0.5%), zearalenone (0.2%) above the established MLs were also notified. Herewith, exceeding MLs of studied mycotoxins were reported only for plant-derived products.

In products of "Cereals and bakery products" category, exceeding MLs of all mycotoxins were detected: aflatoxins (65.4%), ochratoxin A (27.7%), DON (5.4%) and zearalenone (1.5%), in "Fruits and vegetables" category three mycotoxins were prevalent: aflatoxins (70.4%), ochratoxin A (28.4%), and patulin (1.2%).

Of the 1,312 RASFF notifications in 2020–2022, 97.5% mycotoxins were detected in plant-derived foods and 2.5% in feed and feed materials. Moreover, only aflatoxins were found in the feed.

Co-contamination with several mycotoxins was noted in 16 cases, co-contamination with aflatoxins and ochratoxin A was reported in 14 notifications, co-contamination with zearalenone and DON, as well as with zearalenone and aflatoxins were also notified (1 notification for each case).

During the period under review, 76.8% of notifications on mycotoxins concerned border control; 12.3% were made following official market control; 10.8% resulted from internal inspections; 0.1% reported consumer complaints.

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INFORMATION ABOUT THE AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

Selime S. Ibragimova, Leading Veterinarian, Microbiological Testing Unit, Crimean Testing Laboratory, Federal Centre for Animal Health, Simferopol, Republic of Crimea, Russia; *https://orcid.org/0000-0003-3886-7702, ibragimova@arriah.ru*

Olga V. Pruntova, Dr. Sci. (Biology), Professor, Chief Researcher, Information and Analysis Centre, Federal Centre for Animal Health, Vladimir, Russia; *https://orcid.org/0000-0003-3143-7339, pruntova@arriah.ru*

Ибрагимова Селиме Серверовна, ведущий ветеринарный врач отдела микробиологических исследований КрымИЛ ФГБУ «ВНИИЗЖ», г. Симферополь, Республика Крым, Россия; *https://orcid.org/0000-0003-3886-7702, ibragimova@arriah.ru*

Прунтова Ольга Владиславовна, д-р биол. наук, профессор, главный научный сотрудник информационно-аналитического центра ФГБУ «ВНИИЗЖ», г. Владимир, Россия; *https://orcid.org/0000-0003-3143-7339, pruntova@arriah.ru*

Natalya B. Shadrova, Cand. Sci. (Biology), Head of Department for Microbiological Testing, Federal Centre for Animal Health, Vladimir, Russia; *https://orcid.org/0000-0001-7510-1269, shadrova@arriah.ru*

Tatyana V. Zhbanova, Cand. Sci. (Biology), Junior Researcher, Education and Scientific Support Department, Federal Centre for Animal Health, Vladimir, Russia; *https://orcid.org/0000-0002-9857-5915, zhbanova@arriah.ru*

Шадрова Наталья Борисовна, канд. биол. наук, заведующий отделом микробиологических исследований ФГБУ «ВНИИЗЖ», г. Владимир, Россия; *https://orcid.org/0000-0001-7510-1269, shadrova@arriah.ru*

Жбанова Татьяна Валентиновна, канд. биол. наук, младший научный сотрудник отдела образования и научной информации ФГБУ «ВНИИЗЖ», г. Владимир, Россия; *https://orcid.org/0000-0002-9857-5915, zhbanova@arriah.ru*

Contribution of the authors: Ibragimova S. S. – research conceptualization, data search, analysis and interpretation, compilation of tables and graphical material for data visualization, article drafting and writing; Pruntova O. V. – supervision, scientific consultations, research conceptualization, article drafting and writing; Shadrova N. B. – scientific consultations on RASSF searches and analysis, article drafting and writing; Zhbanova T. V. – article drafting and writing.

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