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Aspects Regarding the Control of Mycotoxins

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Abstract

The branch of public health has always faced a rather big problem - the presence of mycotoxins. The most feared are the carcinogenic ones, which should be excluded from the food sector. Due to the fact that the population has no way to be totally safe from the effect of mycotoxins, certain levels of tolerance have been established by the official bodies, thus, at the global level, regulations have been implemented regarding the maximum allowed limits of mycotoxins, having consumer protection center. The epidemiological risk due to the contamination of feed, food with compounds of a mycotoxic nature has involved international bodies such as: the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the United Nations Organization (UNO) through the United Nations Environment Program (UNEP). In order to ensure a high level of protection of human health, the Rapid Alert System for Food and Feed (RASFF) was created within the European Community. These regulations were the basis for the development of national and international programs, with the aim of preventing the multiplication of fungi in plant substrates that end up in human and animal food, as well as the control of their contamination with mycotoxins.

Introduction

On a global level, the concerns in the field of mycotoxicology mainly aim at two important objectives: the standardization of work methodologies for the separation, identification and evaluation of mycotoxins and the establishment of their maximum permissible limits in food and feed. Cereals and cereal-based products are the main source of mycotoxins for the European population.Since 2002, with the introduction of Regulation (EC) No 178/2002 establishing the principles and general requirements of food legislation, the system has worked better, the classification of information has started to be done according to the degree of risk and the need for direct action: notifications alert, information and news notifications. About 89% of food and 98.6% of feed notifications for mycotoxin contamination were attributed to aflatoxin contamination. There are three major types of RASFF notifications: alert, information and border rejection. Alert notifications are found when the hazard is detected in food and feed is already present in the EU. Information notifications are used when a hazard is detected in food or feed is placed on the market in one EU country but has not reached other EU countries. In this case, the risk does not require quick action. There are two subtypes of push notifications: "follow-up push notifications" and "attention push notifications". Border rejections refer to consignments of food and feed that have been rejected at the external borders of the EU due to the presence of a hazard in food and feed (EU Regulation 16/2011).

The dangerousness of mycotoxins and control organizations

Most substances with a carcinogenic effect have also been shown to have mutagenic action, since carcinogens and mutagens have a point of metabolic convergence, namely that they require specific metabolic activation in vivo before exerting their inductive action in living systems. The International Agency for Research on Cancer has evaluated and classified the carcinogenic response of mycotoxins. According to this classification, patulin (PAT) and zearalenone (ZEA) belong to Group 3: non-carcinogenic to humans. Aflatoxin B_1 (AfB_1) is included in Group 1: Carcinogenic compound for humans. Fumonisins and ochratoxin A are probable Group 2 human carcinogens. Fumonisins have been associated with liver cancer in rats and outbreaks of esophageal cancer in humans, and ochratoxin can cause tumors in the kidneys and urinary tract. The major epidemiological risk due to the contamination of plant substrates with toxic compounds of a mycotoxin nature has involved international bodies such as the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the United Nations Organization (UNO) through the United Nations Environment Program (UNEP)). At these conferences, a series of actions were proposed with the aim of reducing the impact of mycotoxins on consumer health and preventing the degree of mycotic and mycotoxin contamination. These recommendations were the basis for the development of national and international programs to prevent the multiplication of micromycetes in plant substrates that end up in human and animal food, as well as the control of their contamination with mycotoxins. In order to ensure a high level of protection of human life and health within the European Community, the Rapid Alert System for Food and Feed (RASFF) was created, which provides the public with a real-time exchange of information. Organizations such as the Joint Expert Committee on Food Additives act as a scientific advisory body to the World Health Organization and the Food and Agriculture Organization. The Expert Committee provides data on toxicity assessments of additives, residues of veterinary medicinal products and contaminants. In Romania, the Food Safety Supervision and Control Program provides for the control of contaminants in food of animal origin, in accordance with the provisions of Regulation (EC) no. 1881/2006 of the Commission of 19 December 2006 establishing maximum levels for certain contaminants in food products. In the case of contaminants considered to be carcinogenic, genotoxic or in cases where the current exposure of the population or vulnerable population categories is close to or exceeds the tolerable dose, the maximum levels should be as low as possible. This regulation sets the maximum levels at the lowest possible values especially for food intended for children which can be obtained through a strict selection of the raw materials used, with the aim of protecting this category of vulnerable population.

Recently, RASFF reported 5045 and 439 notifications of mycotoxin contamination in food and feed, respectively, exported to EU countries worldwide during 2010-2019. Among food notifications, 89% (n = 4487) of mycotoxin contamination notifications were attributed to aflatoxin contamination. The second mycotoxin reported was ochratoxin A with 10% (n = 507) of RASFF notifications. Deoxynivalenol, fumonisins, zearalenone and patulin were reported in 1.01% (n = 51), 0.71% (n = 36), 0.23% (n = 36) and 0.09% (n = 5) RASFF notifications (Figure 1).

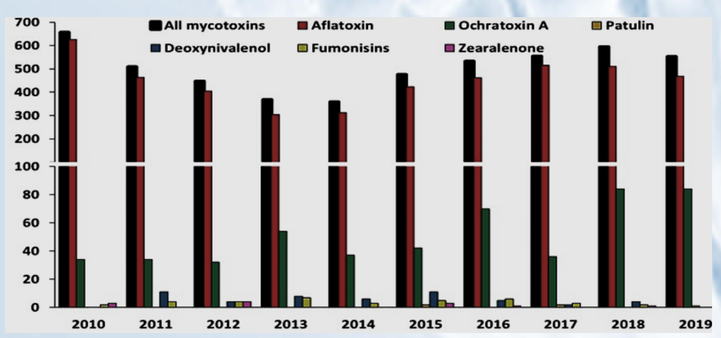

Figure 1. Total number of RASFF notifications for mycotoxins over ten years in food from all countries 2010-2019

The top 10 countries related to 80% of RASFF mycotoxin notifications on food were Turkey (32.7%), China (15.1%), India (12.2%), USA. (10.7%), Iran (9.5%), Argentina (8.0%), Egypt (4.8%), Brazil (2.6%), Pakistan (1.7%), Nigeria (1.5%) and Ghana (1.3%) (Figure 2). However, between 2010 and 2019, mycotoxin notifications were reported for more than 97 countries, including the EU.

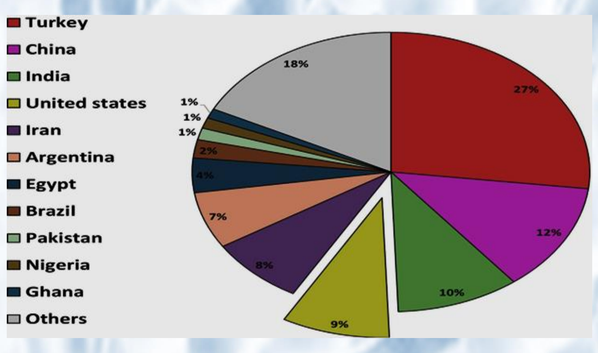

Figure 2. Percentage of RASFF notifications for mycotoxins in food by country of origin

For feed products in all countries, aflatoxin contamination was reported in 98.4% of RASFF notifications. Of these, 77.9% of the contaminated feed products were peanuts, and 11.6% were corn. Sunflower seed, cottonseed, rice bran, sorghum and compound feed have also been reported to be contaminated with aflatoxins.

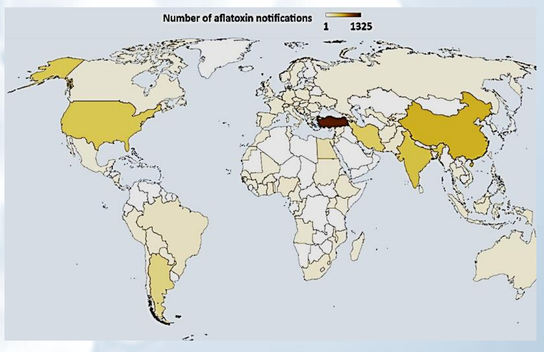

Figure 3. Number of RASFF notifications for mycotoxins in food products during 2010-2019

Factors affecting the promulgation of mycotoxin regulations

A variety of factors can affect the promulgation of mycotoxin limits and regulations. These include: availability of mycotoxin toxicological data: availability of mycotoxin exposure data; knowledge of the distribution of mycotoxin concentrations in batches of goods or products; availability of analytical methods; the legislation of other countries with which there are commercial contacts; the need for sufficient food supply. The first two factors provide the information needed for hazard assessment and exposure assessment, respectively, the main bases of risk assessment. Risk assessment is the scientific assessment of the likelihood of known or potential adverse health effects resulting from human exposure to foodborne hazards. It is the primary scientific basis for the promulgation of regulations. The third and fourth factors are important factors that enable the practical application of mycotoxin regulations through appropriate sampling and analysis procedures. The last two factors are only socio-economic in nature, but are equally important in the decision-making process to establish meaningful regulations and limits for mycotoxins in food and feed. The direct or indirect influence of European organizations and programs on EU mycotoxin regulatory developments is significant. These include the European Food Safety Authority, Scientific Cooperation in Food Matters, the Rapid Alert System for Food and Feed, the creation of an EU Community Reference Laboratory for Mycotoxins and an EC mandate to the European Committee for Standardization in Methods of Analysis of mycotoxins in food. Also important are large pan-European research projects and networks such as 'BioCop' and 'MoniQA'.

Worldwide regulations on mycotoxins

EFSA is an independent body of the European Commission, established in 2002, charged with, among other tasks, developing risk assessments on issues of concern in the food and feed supply. Since July 2006, the European Commission's Joint Research Centre/Institute for Reference Materials and Measurements (Geel, Belgium) has served as the EU Community Reference Laboratory (CRL) for mycotoxins. Among other tasks, the LCR for mycotoxins was created to take initiatives and coordinate activities related to the development, improvement and application of sample preparation methods and methods of analysis for the official control of maximum levels of mycotoxins in food and feed. Without intentionally ignoring other relevant EC projects, examples of projects with potentially significant impact include 'BioCop' and 'MoniQA'. These two projects are funded under the EC's 6th Framework Programme. "BioCop" is an integrated project (IP) with more than 30 partners focusing on "new technologies to screen for multiple chemical contaminants in food". "MoniQA" is a Network of Excellence (NoE), at the time of writing, it has just started operating from 2007–2011. MoniQA is aimed at multidisciplinary themes, called "clusters". One of the main groups is "mycotoxins". A key activity is the development of common strategies for the harmonization and validation of (rapid/novel) detection methods and technologies. With the funding of BioCop and MoniQA, the European Commission has not ceased its interest in advancing the development and standardization of analytical and sampling methods for contaminants, including mycotoxins.

Conclusions

Public health officials face a complex problem - mycotoxins, especially carcinogenic mycotoxins, should be excluded from food as much as possible. Since the substances are present in food as natural contaminants, human exposure cannot be completely prevented and population exposure to a certain level of mycotoxins must be tolerated. At the same time, the analytical methodology must be capable of reliable and practical determination of these toxins at tolerance levels. Despite the dilemmas, mycotoxin regulations have been established in many countries in recent decades, and newer regulations are still being developed. The regulations have become more diverse and detailed, with newer requirements on official sampling procedures and analytical methods. Harmonization of tolerance levels occurs in several free trade areas. In the EU in particular, the number of harmonized regulations for mycotoxins in food has grown rapidly and will grow even more in the coming years. Within a year or two, EU limits will exist for around 50 different toxin-food combinations. These developments are scientifically supported, supported and flanked by the complementary activities of a variety of European organizations or programs (eg EFSA, SCOOP, RASFF, CRL and CEN). Several large pan-European research and networking projects (eg BioCop, MoniQA) are also having an effect. It is therefore expected that in the future the scientific basis and transparency of mycotoxin regulations and the standardization and harmonization of the corresponding (bio)analytical methodology will benefit from these developments.