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REVIEW

STUDY ON THE IMPORTANCE OF AFLATOXINS; DEGRADATION METHODS; MYCOTOXINS PREVALENT IN CORN

Alina Mihalcea*, Sonia Amariei

"Stefan cel Mare" University of Suceava, Faculty of Engineering, Str. Universitatii 13, Suceava, Romania

*Corresponding author: alina.filip@fia.usv.ro

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Abstract: Aflatoxins are mycotoxins produced by fungi of the genus *Aspergillus*. The species *Aspergillus flavus* and *Aspergillus parasiticus* are the main responsible for the appearance of the main types of aflatoxins: aflatoxin B1, aflatoxin B2, aflatoxin G1, aflatoxin G2, but they also produce other non-toxic substances such as sterigmatocystin. The development of aflatoxin-producing fungi occurs in areas with hot, humid climate, and the appearance of aflatoxins is the result of fungal contamination both before and after harvest.

Dietary exposure to aflatoxins is a global problem, due to direct intake of contaminated food, or indirectly, intake of products from animals fed with contaminated feed. The phenomenon of mycotoxin contamination of food is widespread, from European countries to Korea, China, Brazil, Kenya, Africa, Pakistan. In few of these countries there is a program for monitoring, preventing or degrading mycotoxins in corn. This material aims to present the mycotoxins prevalent in corn, the species of fungi producing aflatoxins, the degradation strategies of aflatoxins developed so far, and finally, the importance of preventing this risk for human health.

Keywords: *aflatoxins, corn, degradation methods, fungi, mycotoxins*

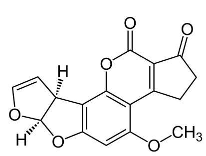
INTRODUCTION

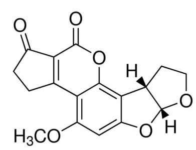
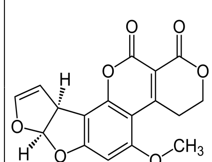
Mycotoxins are toxic secondary metabolites produced by various types of fungi that infect susceptible plants around the world [1, 2]. These toxins are of low molecular weight and are very stable compounds, which can contaminate food, especially cereals, throughout the entire production chain, especially in favorable conditions, before and after harvest. Crops can be infected with several species of mycotoxigenic fungi, and most fungal strains produce more than one type of mycotoxin. Therefore, co-contamination of agricultural products with multiple mycotoxins is frequently observed and recently highlighted [3 – 6]. When raw materials are mixed to produce feed or processed into food, the coincidence of mycotoxin becomes even more likely.
So far, over 400 different types of mycotoxins have been identified with different chemical structures and properties, produced by several different existing fungal species. Among these, there are well-characterized mycotoxin groups, such as aflatoxins (AF), fumonisins (FBs), type A trichothecenes (e.g., T-2 and HT-2 toxin), type B trichothecenes (e.g., deoxynivalenol DON), nivalenol (NIV), zearalenone (ZEN), ochratoxin A (OTA), patulin (PAT), ergot alkaloids (EA), as well as emerging toxins, respectively citrinin (CIT) and enziatins (ENN). Notably, many structurally similar mycotoxins, defined as modified mycotoxins, are generated by plant metabolism, fungi, or food processing and coexist with their native forms [7].

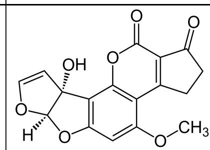
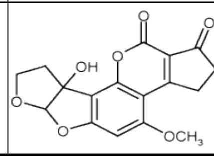
AFLATOXINS

Aflatoxins (Table 1) are among the most common mycotoxins in food. While *Fusarium spp*. is a mold that grows in the field, both *Aspergillus spp*. and *Penicilium spp*. produce storage mycotoxins, such as aflatoxins and ochratoxins. *A. flavus*, *A. nomius* and *A. parasiticus* are the main species that produce aflatoxins. Aflatoxins are difuranocoumarin compounds, produced mainly by two *Aspergillus* species in the flavian section through a polychid pathway [8]. *Aspergillus flavus*, capable of producing aflatoxin B is inherently ubiquitous throughout the world and could colonize many oil-rich crops in both pre-post-harvest stages, such as corn, peanuts and cottonseed [9].

Table 1. *The main species of fungi producing aflatoxins and their optimal development conditions*

<table>
<tr><th>The species of fungus</th><th>Mycotoxins produced</th><th>Chemical structure</th><th>Temp. [C]</th><th>pH</th><th>Place of origin</th><th>Reference</th></tr>
<tr><td>A. flavus</td><td rowspan="5">Aflatoxin B1</td><td rowspan="5"></td><td>12-48</td><td>2-10</td><td>Everywhere</td><td>[10]</td></tr>
<tr><td>A. parasiticus</td><td>12-42</td><td>3-8</td><td>Australia, India, Japan, South America, Uganda, USA</td><td>[11]</td></tr>
<tr><td>A. nomius</td><td rowspan="3"></td><td rowspan="3"></td><td>Brazil, India, Japan, Thailand, USA</td><td>[12]</td></tr>
<tr><td>A. minisclerotigenes</td><td>Argentine, Australia, Nigeria, USA</td><td>[13]</td></tr>
<tr><td>A. parvisclerotigenus</td><td>Nigeria</td><td>[14]</td></tr>
</table>

The species of fungus	Mycotoxins produced	Chemical structure	Temp. [C]	*p*H	Place of origin	Reference
A. pseudocaelatus					Argentine	[15]
A. pseudonomius					USA	[15]
A. pseudotamarii					Argentine, Japan	[16]
A. togoensis					Central Africa	[17]
A. arachidicola					Argentine	[13]
A. bombycis					Indonesia, Japan	[18]
A. flavus	Aflatoxin B2		12-48	2-10	Everywhere	[10]
A. parasiticus			12-42	3-8	Australia, India, Japan, South America, Uganda, USA	[11]
A. nomius					Brazil, India, Japan, Thailand, USA	[12]
A. minisclerotigenes					Argentine, Australia, Nigeria, USA	[13]
A. parvisclerotigenus					Nigeria	[14]
A. pseudocaelatus					Argentine	[15]
A. pseudotamarii					Argentine, Japan	[16]
A. bombycis					Indonesia, Japan	[18]
A. arachidicola					Argentine	[13]
A. parasiticus	Aflatoxin G1				Australia, India, Japan, South America, Ugand, USA	[11]
A. nomius					Brazil, India, Japan, Thailand, USA	[12]
A. minisclerotigenes					Argentine, Australia, Nigeria, USA	[13]
A. parvisclerotigenus					Nigeria	[14]
A. pseudocaelatus					Argentine	[15]
A. arachidicola					Argentine	[13]
A. bombycis					Indonesia, Japan	[18]
A. parasiticus	Aflatoxin G2				Australia, India, Japan, South America, Uganda, USA	[11]
A. nomius					Brazil, India, Japan, Thailand, USA	[12]
A. minisclerotigenes					Argentine, Australia, Nigeria, USA	[13]
A. parvisclerotigenus					Nigeria	[14]
A. pseudocaelatus					Argentine	[15]
A. arachidicola					Argentine	[13]

The species of fungus	Mycotoxins produced	Chemical structure	Temp. [C]	*p*H	Place of origin	Reference
A. bombycis					Indonesia, Japan	[18]
Hydroxylated metabolite of Aflatoxin B1	Aflatoxin M1				-	[19]
Aflatoxin B2 hydroxylated metabolite	Aflatoxin M2				-	[19]

A. flavus and *A. parasiticus* were first discovered in the early 1960s as the main etiological agents of turkey "X disease" leading to the death of over 100,000 turkeys in England [20]. Both *A. flavus* and *A. parasiticus* produce aflatoxin B1 (AFB1) and aflatoxin B2 (AFB2); *A. parasiticus* also produces aflatoxin G1 (AFG1) and aflatoxin G2 (AFG2) [21]. Of the four toxins, AFB1 is the most harmful and is responsible for more than 75 % of food and feed contamination related to aflatoxins [22]. In the liver, AFB1 undergoes cytochrome P450-mediated metabolism, including epoxidation to AFB 1-exo-8,9-epoxide and AFB 1-endo-8,9-epoxide, hydroxylation to aflatoxin M1 (AFM1) and aflatoxin Q1 (AFQ1), and demethylation to aflatoxin P1 (AFP1) [23]. AFB 1-exo-8,9-epoxide covalently binds to DNA, proteins and phospholipids and form adducts, resulting genetical, metabolic modifications and also signaling and cell structure modifications [24].

Aflatoxins are significant due to their abundant appearance, high toxicity and high impact on human health [25]. Aflatoxins are genotoxic and AFB1 can cause hepatocellular carcinomas in humans [8]. Different types of Aflatoxins include B1, B2, G1, and G2. The names of Aflatoxins "B" and "G" are related to the color of the fluorescence observed when exposed to ultraviolet radiation, namely blue (English "blue") and green (English "green"). In addition, M1 and M2 are only found in mammalian milk if the feed consumed has been contaminated with Aflatoxin B1 and B2. The toxicity of these Aflatoxins follows the order: B1 > G1 > B2 > G2 [26, 27]. Aflatoxin B1 has been found in a wide range of agricultural products and is the deadliest known hepatocarcinogen in mammals [28, 29]. Globally, more than 5 billion people are chronically exposed to AFB1 [30]. The overall annual burden of AFB1-induced human hepatocellular carcinoma (HCC) is approximately 155,000 cases, most occurring in sub-Saharan Africa and Southeast Asia [31]. In China, liver cancer is the second most common cancer, accounting for 19.33 % of all cancers [32].

Aflatoxins are the group of fungal toxins of greatest concern for human toxicity [33]. Sorting, cleaning, peeling and grinding can only remove highly contaminated fractions from bulk materials [34]; aflatoxins are quite resistant to ordinary cooking, baking and frying [35]; decomposition temperatures range from 237 to 306 °C [36]. In fact, AFB1 is the most common aflatoxin and the most potent hepatocarcinogen, classified by the International Agency for Research on Cancer (IARC) as a human carcinogen (group 1); aflatoxin AFM1 is classified as possibly carcinogenic to humans (group 2B) [37 – 43].

In terms of animal health, aflatoxins also cause major problems, from acute death to chronic diseases. Clinical signs of animal intoxication include gastrointestinal dysfunction, anemia, jaundice, hemorrhage, and a general decrease in productive parameters, such as reduced weight gain, reduced food efficiency, decreased egg or milk production, lower carcass quality, and increased susceptibility to environmental and microbial stressors [44]. Finally, prolonged exposure to low dietary levels of aflatoxins can lead to functional and structural liver damage, including cancer. It is important to note that lactating animals are also exposed to AFB1, a toxic metabolite secreted in milk (Figure 1) [42 – 46].

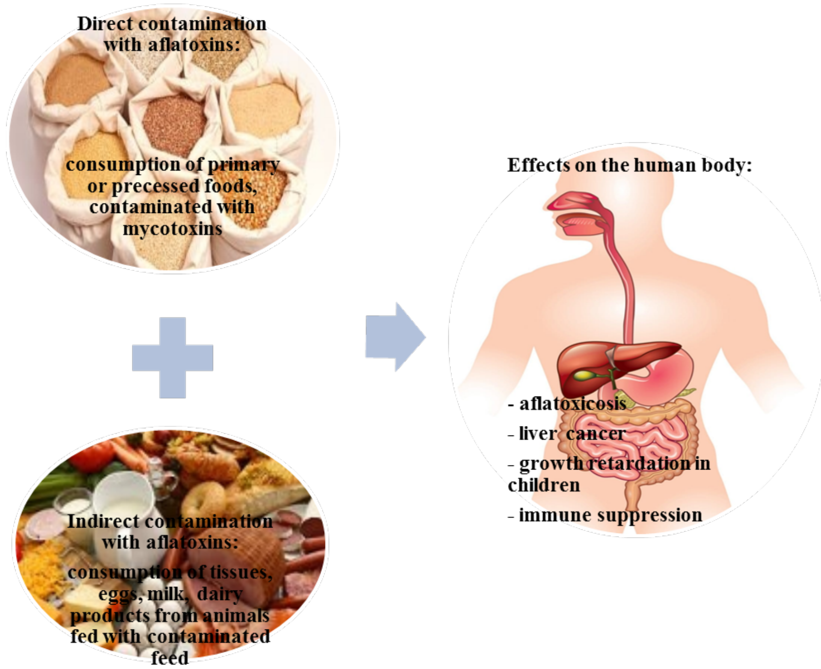


Figure 1. *Ways of penetration of aflatoxins in the human food chain*

The US Food and Drug Administration (FDA) has specified the acceptable limit of maximum 20 $\mu g \cdot kg^{-1}$ for total AF in all foods except milk [47]. In the European Community (EC), even stricter regulations have been established, with maximum levels of 2 and 4 $\mu g \cdot kg^{-1}$ for AFB1 and total AF, respectively, in peanuts, dried fruit and cereals for direct human consumption or as ingredients in food [48]. In China, legal limits for AFB1 in cereal products intended for human consumption range from 5 to 10 $\mu g \cdot kg^{-1}$ as feed levels are allowed to be much higher, reaching upwards from 20 to 50 $\mu g \cdot kg^{-1}$ [49].

STRATEGIES FOR THE DEGRADATION OF AFLATOXINS IN MAIZE

Researchers have struggled over the decades to develop effective strategies for the degradation of aflatoxins in food and feed (Table 2). These strategies are technologically diverse and are based on physical, chemical or biological principles [21].

Table 2. *Methods of degradation of aflatoxins in maize and maize-derived products (since 2010-present)*

The treated product	**The parameters of the applied treatment**	**Aflatoxin [μg·kg^{-1}]**	**Degradation rate [%]**	**Reference**
Degradation of aflatoxins by gamma irradiation				
Maize	10 kGy	AFB1 (57-1210)	85.6-98.6	[50]
Maize	8 kGy	AFB1(50.4)	60.3	[51]
Degradation of aflatoxins by microwave heating				
Alkalized corn	1650 W for 5.5 min	AFB1 (22.5) AFB2 (69.6)	36 and 58	[52]
Cornflour	Microwave heating for 10 min	AFB1 (100)	67.7	[53]
Degradation of aflatoxins by chemical treatment with ozone				
Maize	Ozone gas 90 mg·L^{-1}, for 40 min	AFB1 (83)	88.1	[54]
Maize	Ozone gas 75 mg·L^{-1}; for 60 min	AFB1 (53.6) AFB2 (2.4) AFG1 (12.1)	86.7 70.7 59.3	[54]
Degradation of aflatoxins by treatment with plant extracts				
Maize	Aqueous extract of *Corymbia citriodora* leaf; Incubation at 30 °C and *p*H 8 for 72 h	AFB1 (97.3) AFB2 (47.7)	91.7 88.8	[55]
Maize	Aqueous extract of *Trachyspermum ammi* seed; Incubation at 30° C and *p*H 8 for 72 h	AFB1 (97.3) AFB2 (47.7)	89.6 86.5	[56]
Maize	Aqueous extract of *Ocimum basilicum* leaf; Incubate at 30 °C and *p*H 8 for 72 h	AFB1 (97.3) AFB2 (47.7)	86.9 83.5	[56]
Maize	Aqueous extract of *Allium sativum*, 50 μg·mL^{-1}; Incubate at 25 °C for 1 h	AFB1 (7.47)	68.3	[57]

Physical approaches based on advanced oxidation technology, such as irradiation and cold plasma, allow rapid degradation of aflatoxins [58, 59]. Chemicals involve the use of ozone, electrolyzed oxidizing water, organic acids and natural extracts from plants, which are widely accepted as safe food additives in many countries such as China and the USA [60 – 63]. Biological methods take the form of microbial and enzymatic transformation of aflatoxins into non-toxic or less toxic metabolites [64, 65].

Degradation of aflatoxins by gamma irradiation

Gamma rays are electromagnetic radiation emitted by an unstable source, such as a radioactive isotope (e.g., ^{60}Co, ^{192}Ir, ^{139}Cs, and ^{70}Tm) [21]. Gamma rays are the preferred source of irradiation for food processing due to their high reactivity and penetrability. Irradiation of food up to a total dose of 10 kGy does not cause toxic hazards or special microbiological or nutritional problems [66]. Gamma irradiation can facilitate the radiolysis of water and the generation of highly reactive free radicals such as hydrogen radical (H^-), superoxide radical (O^{2-}) and hydroxyl ion (OH^-), which play an important role in the destruction of aflatoxins [36]. A study by Wang *et al.* (2011) [67] examined the structure of AFB1 radiolytic products. This analysis revealed that the double bond of the terminal furan ring no longer exists in most radiolytic product due to the reaction of free radical addition during gamma irradiation. The double bond in the terminal furan ring of AFB1 is known to be associated with its toxicity [21]. In the liver, oxidation of the double bond in the terminal furan ring of AFB1 by hepatic cytochrome P450 (CYP) enzymes produces AFB 1-exo-8,9-epoxide, which can react with the N 7 guanine atom to generate DNA pro- mutagen [23]. Thus, the loss of the double link of the terminal furan ring in AFB1 after gamma irradiation treatment led to a significant reduction of its cytotoxicity in Pk15, HepG2 and SH-SY5Y cells [68].

Degradation of aflatoxins by microwave heating

Microwaves are electromagnetic waves with frequencies between 300 MHz and 300 GHz with wavelengths from 1 m to 1 mm. The frequency of a household microwave oven is 2450 MHz, while industrial microwave systems generally use either 915 or 2450 MHz [21]. Microwave heating is a unique method of volumetric heating, which converts the energy of the electromagnetic field into thermal energy through the polarizing effect of electromagnetic radiation [69]. In approaching this method of reduction, we must consider the uneven distribution of temperature during microwave heating, which can lead to the formation of cold and hot spots in treated foods [70]. Cold spot aflatoxins cannot be effectively detoxified, while overheating in hot spots can cause nutritional loss and deterioration of quality. Several studies are also needed to optimize process parameters to increase the efficiency of degradation along with elucidating the structure and evaluating the safety of degradation products.
Pérez-Flores *et al.* (2011) [52] evaluated the effect of microwave treatment on aflatoxin-contaminated alkaline maize, and the results showed that AFB1 and AFB2 were reduced by 36 and respectively 58 %, when the contaminated corn was heated in a microwave at a power of 1650 W for 5.5 min. Alkadi and Altal (2019) [71] recently studied the degradation of AFB1 to 67.7 % in cornmeal heated in a microwave oven for 10 min.

Degradation of aflatoxins with ozone

Ozone is a strong oxidizing agent with a redox potential of 2.07 V, capable of detoxifying a wide variety of emerging contaminants in food [72]. Normally, ozone can be produced by several methods, such as ultraviolet irradiation, electric discharge in oxygen and electrolysis of water [73]. Spontaneous decomposition without forming hazardous residues on treated products makes ozone a promising alternative in the food processing industry. Studies on the degradation of mycotoxins by ozone have accelerated after it was granted generally recognized safe status (GRAS) for use in food and water [74]. The mechanism of AFB1 ozonolysis involves an electrophilic attack on the double bond in the difuran ring leading to the formation of a primary ozonide followed by the rearrangement into monozonide derivatives, such as aldehydes, ketones and organic acids [75].
The efficiency of AFB1 degradation with ozone depends not only on the ozone concentration and the exposure time, but also on the moisture content of the food matrix. For example, Luo *et al.* (2014) [76] observed an 88.1 % reduction in AFB1 in maize with 13.47 % moisture compared to a 72.4 % reduction in maize with a 20.37 % moisture content after exposure to ozone at a concentration of 90 $mg \cdot L^{-1}$ for 40 min. Changes in the nutritional properties of foods after ozone treatment should be

considered. A study by Wang *et al.* (2008) [77] showed that ozonation of naturally contaminated maize detoxified 92 % of AFB1 while causing a 3.2 % loss of protein content. In addition, ozone has been reported to alter the fatty acid profile of maize [78].

Degradation of aflatoxins with plant extracts

Natural plant extracts have been widely used as food additives and pharmaceuticals since ancient times for their anti-microbial, anti-inflammatory, antioxidant and immune-boosting activities. The potential use of natural plant extracts in mycotoxin detoxification has received much attention in recent years. Aqueous extracts of *Corymbia citriodora* and *Trachyspermum ammi* have been studied for the degradation of AFB1 and AFB2 in contaminated maize [55, 56]. The authors found that AFB1 and AFB2 in contaminated maize samples were degraded to 91.7 and 88.8 %, respectively, by *C. citriodora* leaf extract, while AFB1 and AFB2 levels were reduced by 89.6 and 86.5 %, respectively, after treatment with *T. ammi* seed extract. Mass spectrometry analysis of the degradation products confirmed that treatment with *C. citriodora* leaf extract led to the modification of the lactone group and the removal of the double bond in the difuran annular portion of AFB1 [55]. Similar results were observed after detoxification of AFB and AFG1 with aqueous *T. ammi* seed extract [56].

Plant extracts are very complex mixtures, and their components vary depending on the plant species and chemotype, phonological stage, tissue and method of extraction [79]. Further studies are needed to provide a deeper perspective on the pattern of action, as well as the potential interactions of natural plant extracts with food and feed matrices.

There are currently modern and effective products on the market that offer protection to animal feed against a wide range of mycotoxins. Mineral adsorbents in them selectively bind through binders, mycotoxins present in food; a combination of enzymes and biological components transforms mycotoxins into non-toxic metabolites, provides protection against mycotoxins through adsorption and bioprotection.

A low-cost test device (Drop sort) was developed, that had a significant effect in reducing fumonisin contamination and a more lab effect in reducing aflatoxin contamination of maize. The sorting is done considering the massive density of the corn kernel and the weight of 100 corn grains. Visual and fluorescence-based sorting, in combination with Drop sorting, had a good effect in separating grains contaminated with aflatoxins [80].

MYCOTOXINS PREVALENT IN MAIZE

In order to understand the prevalence of mycotoxins in maize and its contamination levels, global data were collected about them. Globally, corn is one of the most studied matrices, which could be due to its wide use in both human and animal food. Maize is also one of the species prone to infection with pathogenic microorganisms [80]. In terms of levels found, AFB1 was the mycotoxin that most often exceeded the EU legislative level, with a maximum value of 1137.4 $\mu g \cdot kg^{-1}$ in a sample of raw cereals from Kenya [33]. ZEN, T-2 and HT-2 have also been reported to exceed EU legislative levels in some cases, as shown in Table 3 and Table 4.

Table 3. *Occurrence of mycotoxins in various parts of the world*

The analyzed product	Country of origin	Mycotoxins detected	Limits [µg·kg⁻¹]	Percentage of positive samples [%]	Average value [µg·kg⁻¹]	Reference
Maize	Serbia	DON	260.1-1388 260.4-9050 252.3-6280	2.5 96.0 15.5	642.3 363.3 921.1	[81]
Maize	Poland	DON T-2 HT-2 ZEN FM OTA AF	≤1.0-7860 ≤0.2-550 ≤0.7-1583 ≤0.07-521 ≤1.6-1885 ≤0.13-86.0 0.18	88 67 68 92 58 11 2	766 22.8 37.6 75.3 272 13.9 -	[82]
Maize	Croatia, Bosnia and Herzegovina	T-2 / HT-2	31.2-336.2 28.7-321.2	57.9 53.3	101 125.2	[83]
Maize	England	DON ZEN FB1 FB2 T2, HT2	≥10.0-7111 ≥10.0-3901 ≥1-107 ≥1-24 0	70 66 10.4 2.5 0	603 209 24 24 0	[84]
Maize	Norway	AFB1 AFB2 AFG1 AF FB1 FB2 FB1 + FB2	0.13-100.4 7.3-17.4 0.10-0.10 107.88-114.95 31-8750 5-3540 36-12290	46 15 46 15 100 100 100	31.1 12.4 0.10 111.4 1001 354 1355	[85]
Maize	China	AFB1	> 0.5-25.5	80	3.9	[86]
		ZEN	> 10-1442.5	96	251.5	
		DON	> 100-4320.9	98	755.1	
Maize	Brazil	FB1	16-1732	80	289	[87]
		FB2	32-743	47	254	
Maize	South Korea	DON	≥ 3.3-232.56	22.6	190.78	[88]
Maize	Tanzania	AF	0.1-269	45	-	[89]
		FB1 + FB2	49-18273	85	-	
Maize	Kenya	AFB1	≥ 1.0-1137.4	78	16.0	[90]
Maize	Egypt	AFB1 AFB2 DON FB1 FB2 FB3 OTA ZEN	0.3-197.5 0.42-9.8 26-807 1-2453 1.3-386 1.5-286 2.8-11 0.46-184	16 5 8 51 18 8 3 13	-	[91]
Maize	South Africa	AF ZEN DON T-2 FB1 + FB2 OTA	> 0.5-14 > LOD-6276 > LOD-9176 > LOD-80 > LOD-16932 > LOD-95	9.6 47.1 80.6 0.7 80.1 7.4	-	[92]
Maize	Pakistan	OTA	5.18-198.68	69.7	118.23	[93]

Table 4. *Occurrence of mycotoxins in Romania*

The analyzed product	Region	Mycotoxins detected	Limits [µg·kg^{-1}]	Percentage of positive samples [%]	Average value [µg·kg^{-1}]	Reference
Raw material cereals	Western Plain, Transylvania, Moldavia, southern hilly area, Southern Plain, Oltenia, Dobrogea	DON	18.5 230.87	43	48.08	[94]
Processed cereals		DON	18.5 1269.94		116.98	
Cereal based food		DON	18.5 92.58		22.87	
Raw material cereals		AF	1.75 82.94	46	7.06	
Processed cereals		AF	1.75 8.34		1.93	
Cereal based food		AF	1.75		1.75	
Raw material cereals		OTA	2.50 3.39	6.8	2.55	
Processed cereals		OTA	2.50 6.72		2.84	
Cereal based food		OTA	2.50		2.50	
Raw material cereals		ZEN	1.75	7.1	1.75	
Processed cereals		ZEN	1.75 7.05		2.08	
Cereal based food		ZEN	1.75 3.38		1.80	
Corn grains	Bacau county	OTA	1.054	0	1.054	[95]
Corn grains		ZEN	2.061 14.13	50	3.75	
Corn grains	Iasi county	DON	41.00 446.96	42.3	231.68	[96]
Corn grains	North-West	AF 2018	0.13-2.30	16.67	0.82	[97]
		AF 2019	0.95-3.62	33.33	1.82	
Corn grains	Central	AF 2018	0.07-3.72	25	1.06	
		AF 2019	0.65-1.63	0	1.13	
Corn grains	North-East	AF 2018	0.23-3.00	50	1.55	
		AF 2019	0.68-3.06	36.36	1.57	
Corn grains	South-East	AF 2018	0.41-3.65	18.60	1.10	
		AF 2019	0.54-4.28	43.59	3.63	
Corn grains	Bucharest-Ilfov	AF 2018	n.a.	0	0.30	
		AF 2019	0.55-1.09	0	0.83	
Corn grains	South-West Oltenia	AF 2018	0.56-3.13	14.29	1.28	
		AF 2019	0.42-5.67	66.67	2.74	
Corn grains	West	AF 2018	0.60-5.48	16.67	1.75	
		AF 2019	0.79-1.71	0	1.10	

Analyzing the data from Table 4, we can say that the main mycotoxins that contaminate corn crops in Romania are aflatoxins, deoxynivalenol and zearalenone.

CONCLUSIONS

World need for goods commonly used in the manufacture of food for humans and animals, such as corn, has grown steadily in recent years, driven by higher request for production and consumption. Review of Commission Implementing Regulation (EU) 2019/1793 [98] on the contamination with regulated mycotoxins has made us realize that this is an increasingly relevant issue. The RASFF report (Rapid Alert System for Food and Feed) for 2019 shows the existence of 534 notifications regarding mycotoxin contamination of food products [99]. Aflatoxins are the most detected mycotoxins in food in the EU, especially in nuts of non-EU origin. Most notifications related to the country of origin of the product are for Turkey (104). Within the Codex Committee on Contaminants in Food (CCCF), discussions on maximum levels (MLs) and an associated sampling plan for aflatoxins in various foods are ongoing. The occurrence of aflatoxin should be further monitored in the light of potential increases due to climate change using methods with high levels of sensitivity for detection, as recommended by the EFSA Group on Food Chain Contaminants (CONTAM) [100]. In general, the common association of maize with aflatoxins and fumonisins has been found, but the formation of mycotoxins is a complex and multifactorial phenomenon whose patterns of global contamination and distribution are predicted to be significantly affected by climate change due to environmental conditions favorable for the proliferation of fungi in less common places. The appearance of mycotoxins is unpredictable and, therefore, research on several mycotoxins is more realistic and is preferable to those focused on a particular contaminant, the co-occurrence of mycotoxins being reported more and more frequently. Studies on the degradation methods of aflatoxins show encouraging results, but many of them are performed in laboratory conditions [21]. Their application involves the fulfillment of several requirements of effectiveness, safety, acceptance by the consumer. We consider that the degradation methods presented have a good potential for the development of feasible technologies.

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