Exposure assessment to mycotoxins - Challenges and approaches to follow

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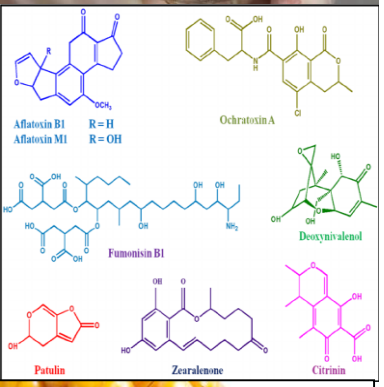
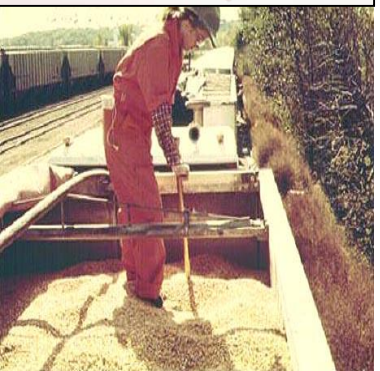




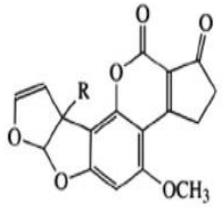
1. What are mycotoxins

Mycotoxins are fungi metabolites produced by specific fungal genera, primarily *Aspergillus*, *Penicillium*, *Alternaria*, *Fusarium* and *Claviceps*.

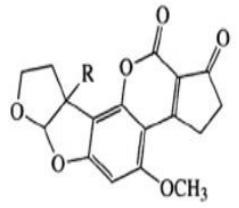
Mycotoxin molecules are small and stable, with a low molecular mass.

A specific fungal species may produce several different mycotoxins due to the influence of various types of environmental stress.

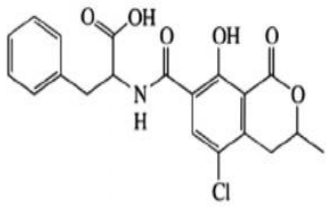
Halstensen, 2008



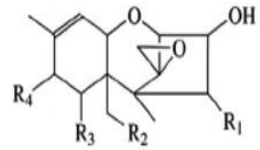
Aflatoxin B1 R=H
Aflatoxin M1 R=OH



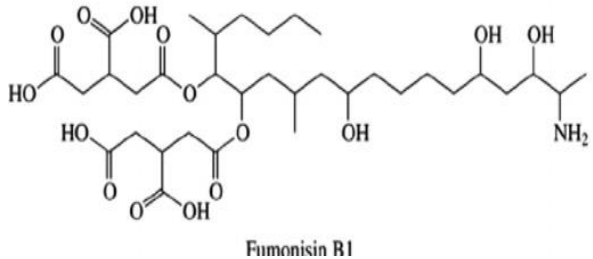
Aflatoxin B2



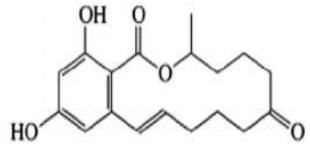
Ochratoxin A



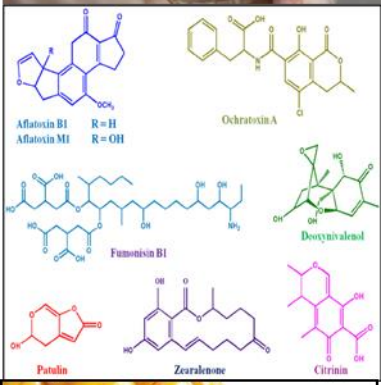
	R_1	R_2	R_3	R_4
Deoxynivalenol	H	OH	OH	=O
T-2	OAc	OAc	H	$-OCOCH_2CH(CH_3)_2$
NT-2	OH	OAc	H	$-OCOCH_2CH(CH_3)_2$

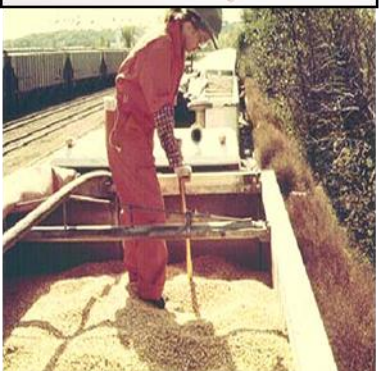


Fumonisin B1



Zearalenone





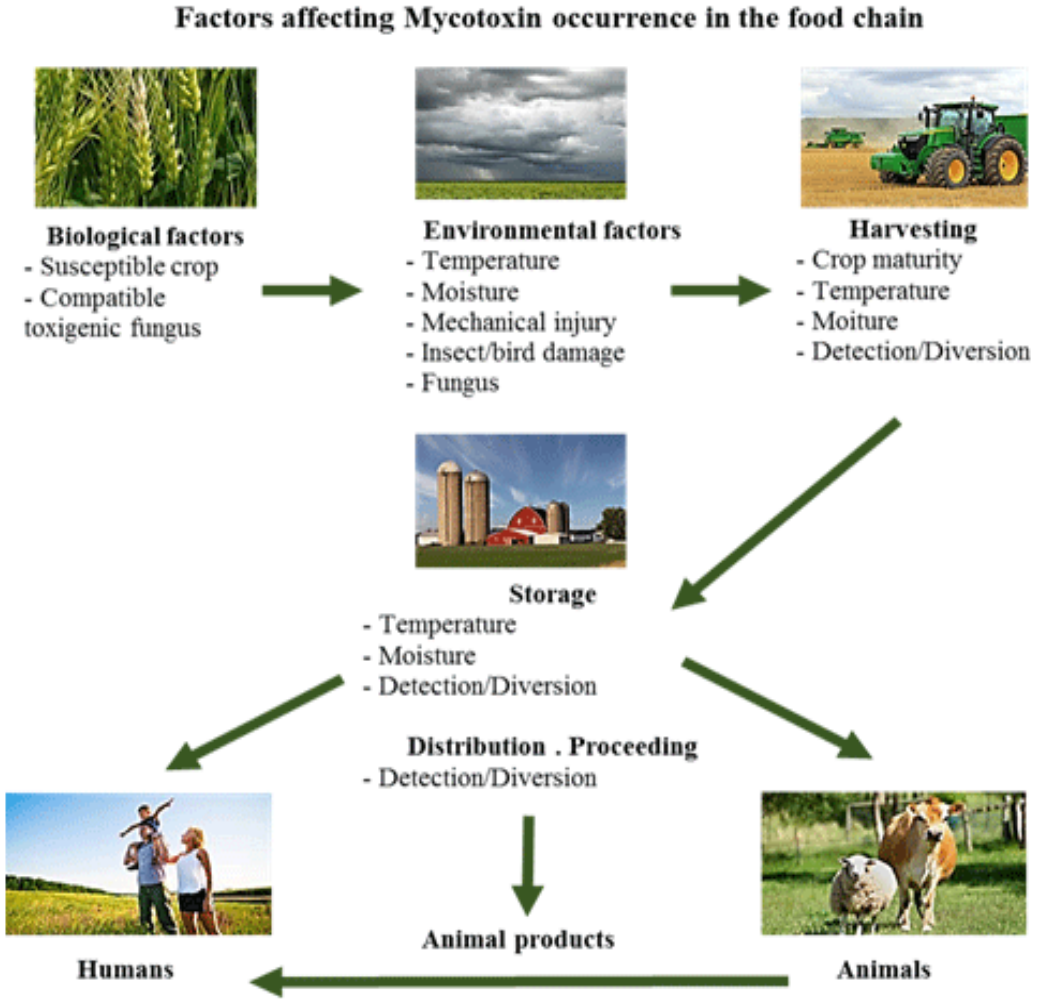
2. Why we are expose?

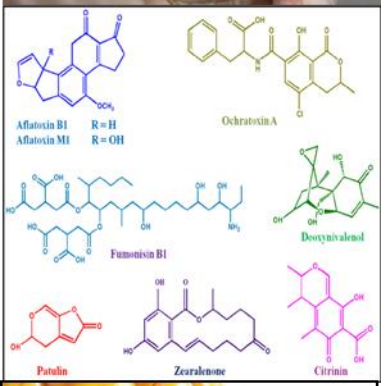
Mycotoxins can be present in the environment in the absence of any visible fungi since they can resist to adverse environmental factors (high or low temperatures) and can persist long after the death of the fungal species responsible for their production.

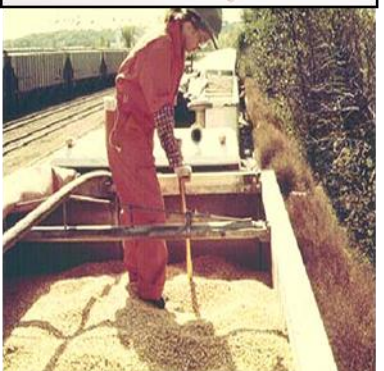
Halstensen, 2008

They are also difficult to eliminate or inactivate from the source even after being exposed to temperatures such as boiling or roasting processes.

Peraica et al., 1999







3. How we are exposed?

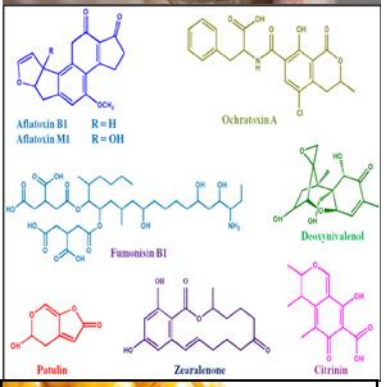
Food Consumption

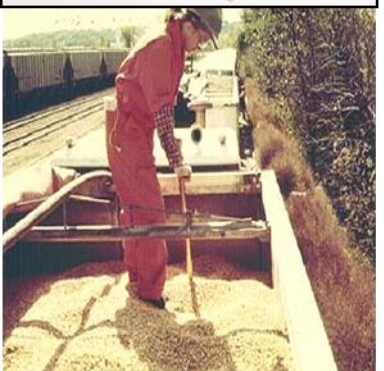
Several mycotoxins can be found in food: aflatoxins, ochratoxin A, sterigmatocystin, trichothecenes (type A: HT-2 and T-2 toxin; type B: deoxynivalenol), zearalenone, fumonisins B1 and B2, and the **emerging mycotoxins** (fusaproliferin, moniliformin, beauvericin, and enniatins), ergot alkaloids and altenuene, alternariol, alternariol methyl ether, altertoxin, and tenuazonic acid.

Bottalico & Logrieco, 1998; Barkai-Golan & Paster 2008; Marin et al., 2013.

Some of these are not regulated and were shown to occur frequently in agricultural products. The evidence of their incidence is rapidly increasing and gaps in toxicological knowledge have been identified for several compounds not allowing a proper risk assessment.

Gruber-Dorninger et al., 2017



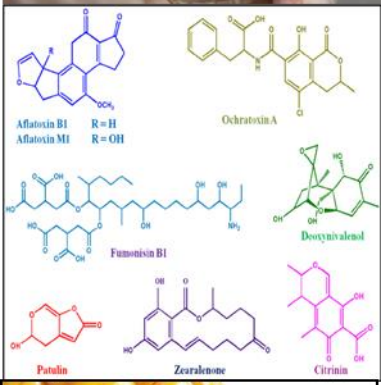


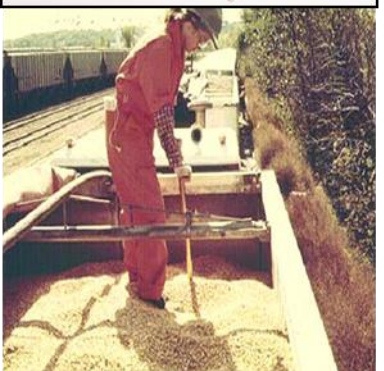
3. How we are exposed?

Occupational Exposure

Dust containing mycotoxins is released during tasks involving high exposure to organic dust, such as storage work, loading, handling, or milling contaminated materials (grain, waste, and feed), and others such as caring for animals in animal husbandry settings.

Animal feed processing plants are particularly risky since the authorized level of concentration in this type of food is ten times higher than it is for human food.





3. How we are exposed?

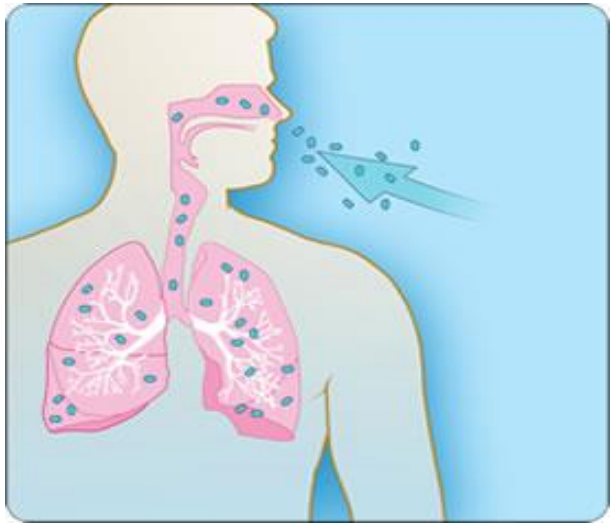
Occupational Exposure

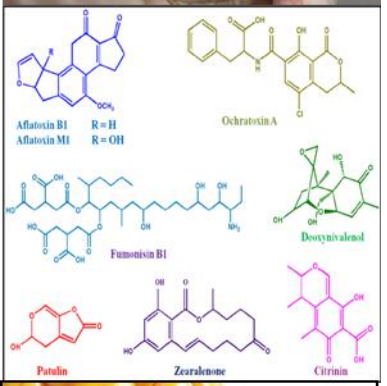
Mycotoxins can be present in airborne dust that act as carrier of mycotoxins to the workers respiratory system – **Inhalation is a important exposure route.**

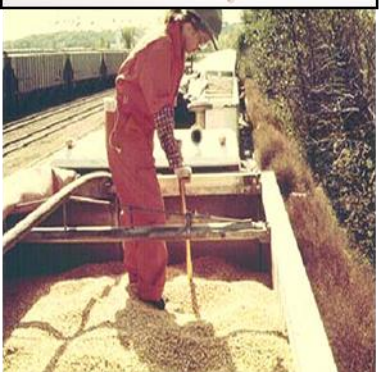
Lavicoli et al., 2002; Brera et al., 2002; Mayer et al., 2007; Mayer, 2015; Viegas et al., 2016

Dermal contact can also be a frequent route of workplace exposure, especially where workers without protection have to handle contaminated materials such as food or waste.

Degen, 2008; Boonen et al., 2012, Viegas et al., 2015







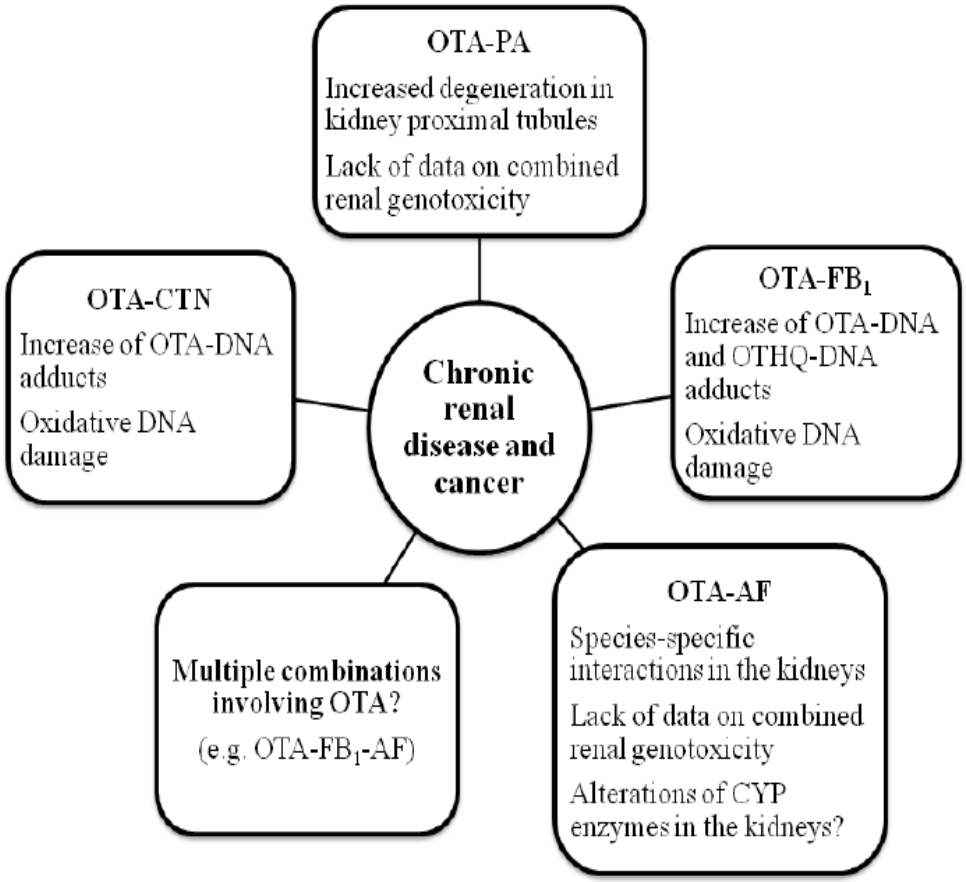
3. How we are exposed?

Exposure to mycotoxins mixtures is the most common exposure scenario since the contamination of foodstuffs by several mycotoxins has frequently been demonstrated

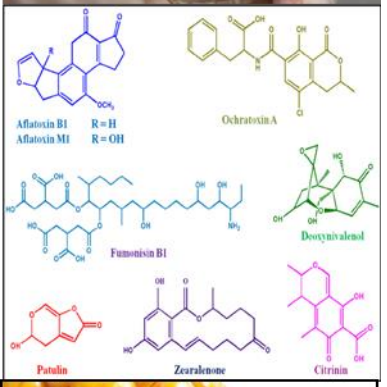
Assunção et al., 2015; Alassane-Kpembi et al., 2017

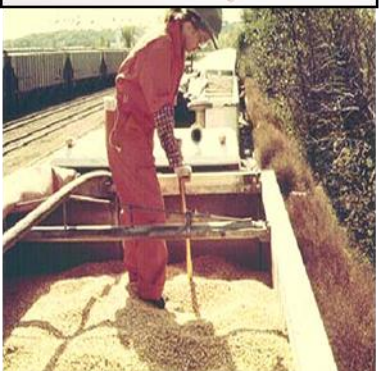
Exposure can happen trough food consumption or during the performance of workplace activities and by both ways simultaneously.

Synergistic or additive effects should therefore also be taken into account when performing a risk assessment, and measurements should look for several mycotoxins.



Klarić et al., 2013. Deleterious Effects of Mycotoxin Combinations Involving Ochratoxin A



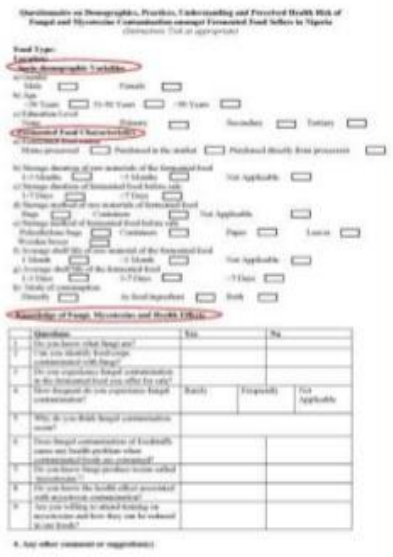


4. How we can study exposure?

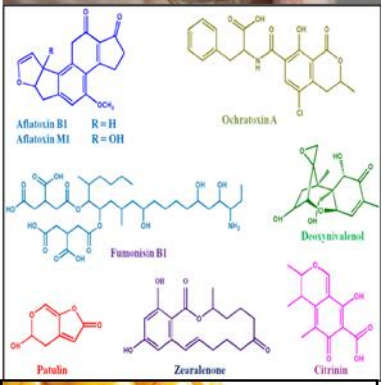
Food Consumption

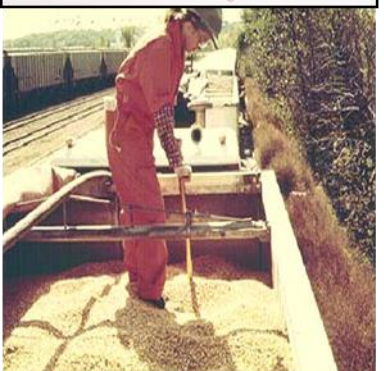
METHODOLOGY

- **Awareness studies**: A descriptive cross-sectional study was carried out amongst fermented food sellers (n=86) in Feburary 2015 using a questionnaire.
- **Location**: South-West Nigeria
- **Sampling**: *ogi* (n=35), *iru* (n=60), *ogibaba* (n=35), *ugba* (n=30), *ogiri* (n=31)
  Period: Feburary 2015 – May 2016
  Total: 191 samples
- Storage: -18°C
- Mycotoxin analysis: Laboratory of Food Analysis, Ghent University, Belgium.



How often, in the past 3 months, did you eat the following?	never	Less than 1 time per week	1-3 times per week	4-6 times per week	1 time per day	2-3 times per day	4 or more times per day	What was your usual serving size, relative to the following?	1	½ or less	1 ½ or more
Fruit (apples, bananas, oranges, etc.)								½ cup raw fruit; ½ medium apple or large orange			
Vegetables (carrots, mushrooms, potatoes, etc.)								½ cup cooked or raw; 1 carrot or stalk celery			
Chicken (fried chicken, in soup, grilled chicken, etc.)								3-4 oz; ½ large or 1 small breast; 2 drumsticks			
Turkey (turkey dinner, turkey sandwich, in soup, etc.)								3-4 oz; 6-8 very thin slices; 1-3 thick slices			
Fish and Seafood (tuna, shrimp, crab, etc.)								3-4 oz; 1 can of tuna; 6 medium shrimp			
Pork (ham, pork chops, ribs, etc.)								3-4 oz; 1 pork chop; 2 ribs; 3-4 slices bacon			
Beef (steak, meatballs, in tacos, etc.)								3-4 oz; ¼ lb burger; 3-6 slices roast beef			
Other Meat (duck, lamb, venison, etc.)								3-4 oz; a piece about the size of your palm			
Nuts (almonds, cashews, walnuts, etc.)								¼ cup or 1 handful; 20 almonds; 2 tbsp nut butter			
Beans (tofu, chickpeas, chili, etc.)								½ cup cooked beans; ¼ cup hummus or tofu			
Dairy (cheese, milk, yogurt, etc.)								3 slices cheese; 1 cup milk; 1 cup yogurt			
Eggs (omelet, in salad, in baked goods, etc.)								1 egg; ¼ cup scrambled eggs or ½ cup egg salad			
Grains (breads, pasta, rice, etc.)								1 slice bread or pizza; ½ cup rice or pasta			
Sweets (candy, cookies, pie, etc.)								2 small cookies; 1 slice cake or pie			
Caffeinated Soft Drinks (cola, diet cola, energy drinks, etc.)								1 can (12 oz) soda; small fountain drink			
Coffee and Tea (hot coffee, iced coffee, black tea, etc.)								6 oz hot coffee or tea; small iced coffee			





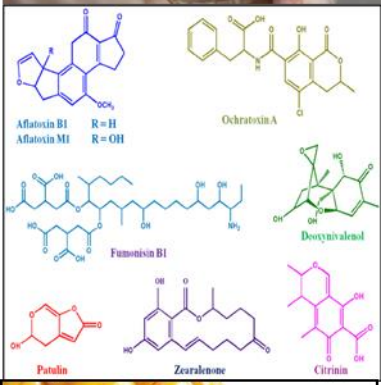
4. How we can study exposure?

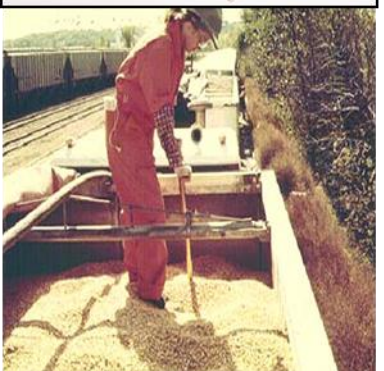
Occupational exposure

Exposure can vary greatly between different tasks within the same industry, and characterizing exposure implies performing measurements on each task separately to identify those most at risk. **Personal sampling is the best way.**

Within the same task, levels of exposure could also vary over time depending on the quality of the materials and products handled.

Viegas et al., 2018





4. How we can study exposure?

Biomonitoring

As an alternative or as a complement to food contamination assessment or air monitoring, biomonitoring is another way of assessing exposure to mycotoxins.

Biomonitoring can include the detection, in blood and urine, of the mycotoxin and its metabolites.

De Nijs et al., 2016

The use of biomonitoring implies the availability of information related with each mycotoxin toxicokinetics, metabolism, and bioavailability to be able to interpret correctly the results.

Escrivá et al., 2017


Food and Chemical Toxicology 62 (2013) 927–934

Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Bio-monitoring of mycotoxin exposure in Cameroon using a urinary multi-biomarker approach

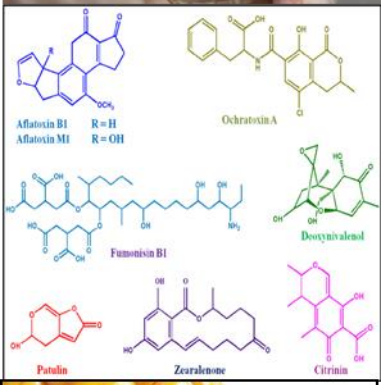
Wilfred A. Abia [a,b,c], Benedikt Warth [b], Michael Sulyok [b], Rudolf Krska [b], Angele Tchana [a], Patrick B. Njobeh [c], Paul C. Turner [d], Charles Kouanfack [e], Mbu Eyongetah [f], Mike Dutton [g], Paul F. Moundipa [a,*]

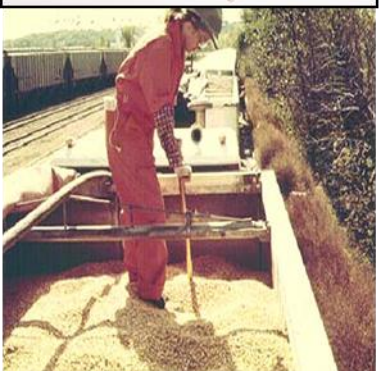

Mycotoxin Research
https://doi.org/10.1007/s12550-017-0302-1

ORIGINAL ARTICLE

Enniatin B and ochratoxin A in the blood serum of workers from the waste management setting

Susana Viegas [1,2] · Bernd Osteresch [3] · Ana Almeida [1] · Benedikt Cramer [3] · Hans-Ulrich Humpf [3] · Carla Viegas [1,2]





4. How we can study exposure

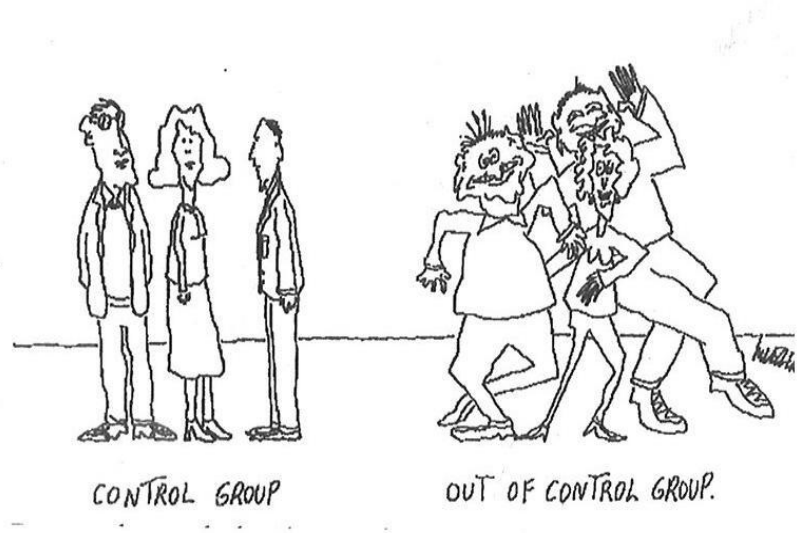
Biomonitoring

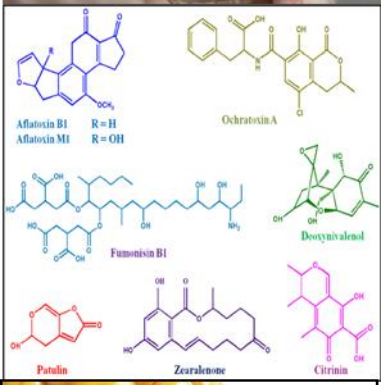
For occupational exposures data on background dietary exposure to mycotoxins is needed to determine the additional burden of respiratory and dermal exposure in the workplace.

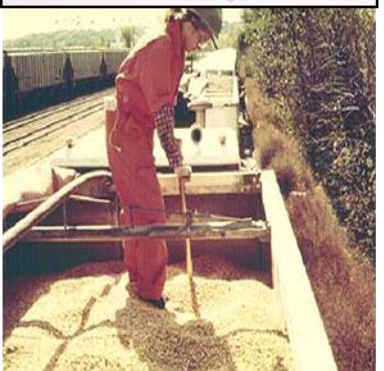
If not available, a control group from the general population should be included in order to exclude the possibility of exposure by diet.

Degen, 2008

Considering that exposure to mycotoxins mixture is the reality, it is extremely relevant to be able to measure several mycotoxins in one sample.

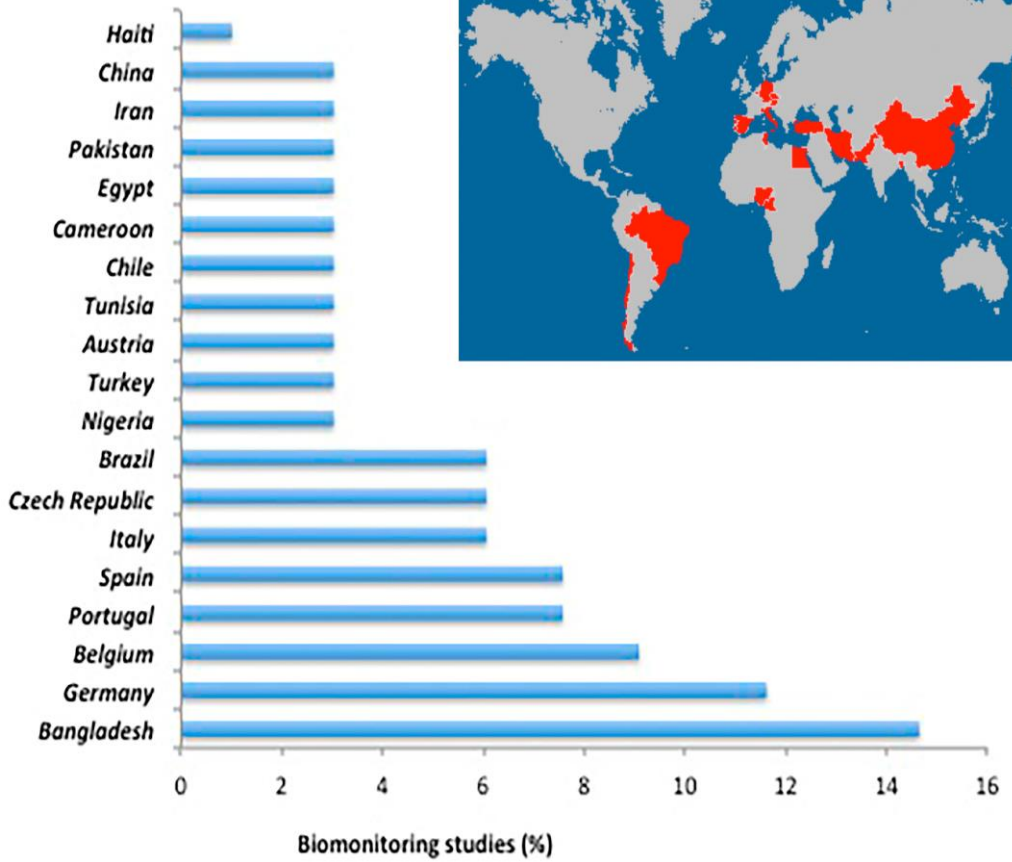






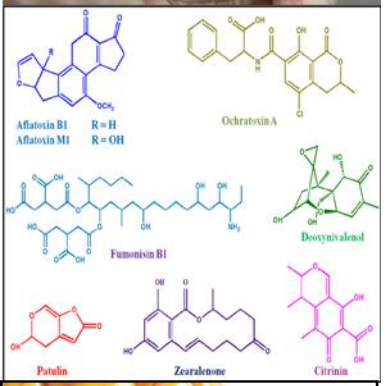
5. Challenges and approaches to follow

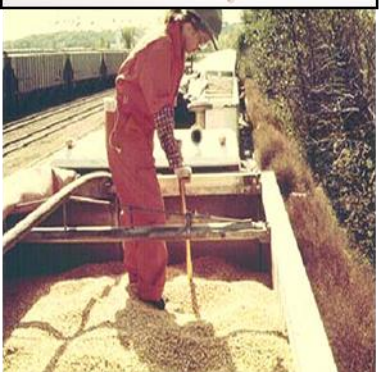
✓ Recognize the most common mixtures reported in food and in occupational settings. **Biomonitoring can be an important tool.**



Percentage of biomonitoring and exposure assessment studies performed through mycotoxin analysis in biological samples worldwide.

Escrivá et al., 2017





5. Challenges and approaches to follow

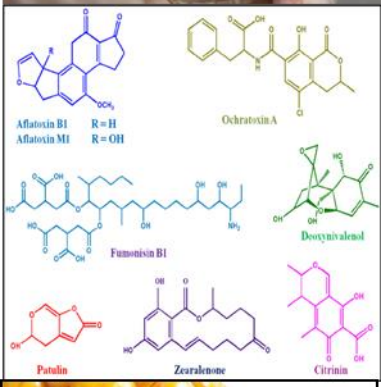
Occupational exposure

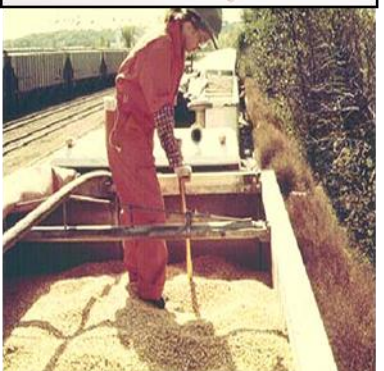
The absence of exposure limits makes difficult to interpret exposure measurements.

Keeping exposure as low as possible should undoubtedly be an objective.

Because these compounds are so infrequently monitored it is impossible to compare exposure levels between different workplaces and to know what constitutes a normal background concentration.

Viegas et al., 2018





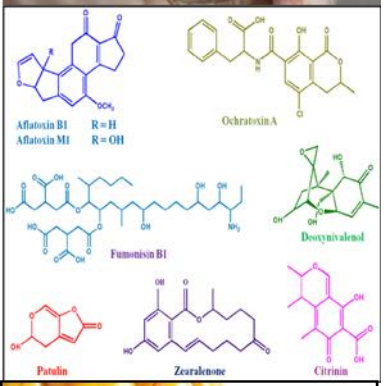
5. Challenges and approaches to follow

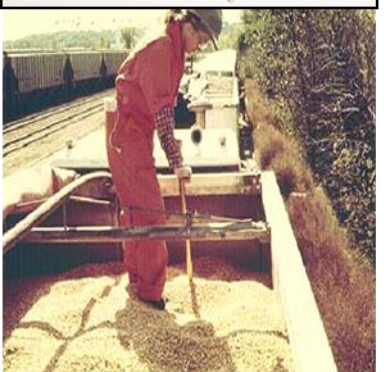
Occupational exposure

- ✓ Important to properly characterize mycotoxin exposure (which mycotoxins, at which concentrations, for which duration) and to understand which factors can influence that exposure.

- ✓ Recognize what workplace exposure adds to the exposure resulting from ingestion of mycotoxin-contaminated food.

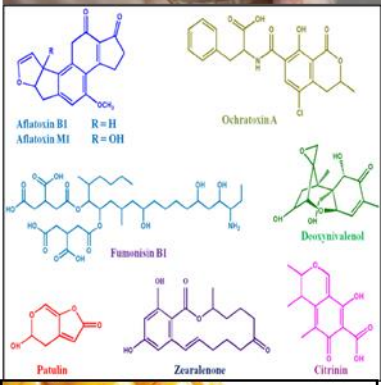
Viegas et al., 2018

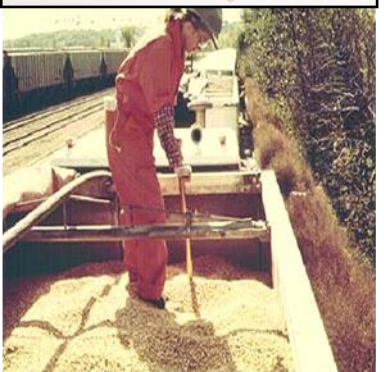




5. Challenges and approaches to follow

- ✓ Understand if there are differences concerning exposure in the EU population Which are the reasons for the reported differences?
- ✓ Is there a significant trend in exposure? Is there a trend associated with exposure to regulated and no regulated mycotoxins?
- ✓ Understand the influence of Climate Change on exposure to mycotoxins.
- ✓ Development and implementation of reference values (OELs, TDI,…) for each mycotoxin separately and for mixtures.





Take home messages:

- ✓ Exposure can happen trough food intake and in specific occupational settings.
- ✓ Exposure occurs to a mixture of mycotoxins in different moments and due to different exposure scenarios.
- ✓ Biomonitoring can help to unveil several relevant aspects: e.g. the most common mixtures, the role of occupational environment in the total exposure to mycotoxins.
- ✓ Need more research to clarify exposure trends in Europe and which variables influence exposure – **HBM4EU project will help to clarify and to show the way to future preventive actions.**

The authors are grateful to Portuguese Authority for Working Conditions for funding several projects related with occupational settings where exposure to mycotoxins can occur.


toxins

MDPI

Article

Exposure Assessment to Mycotoxins in a Portuguese Fresh Bread Dough Company by Using a Multi-Biomarker Approach

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Thank you for your attention!