AFLATOXIN M1 EXPOSURE AND RISK OF EUROPEAN CONSUMERS

ZSUZSA FARKAS, PHD
UNIVERSITY OF VETERINARY MEDICINE, BUDAPEST
INSTITUTE OF FOOD CHAIN SCIENCE
DEPARTMENT OF DIGITAL FOOD SCIENCE

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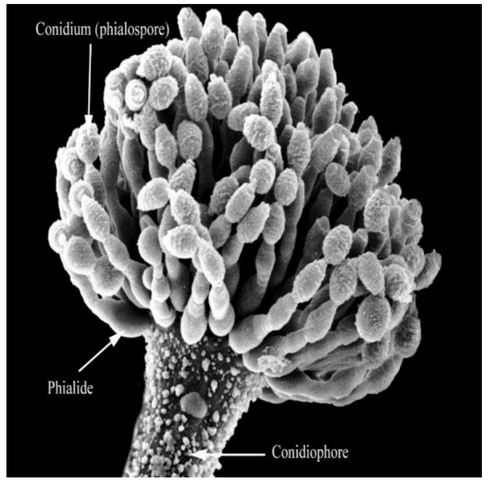
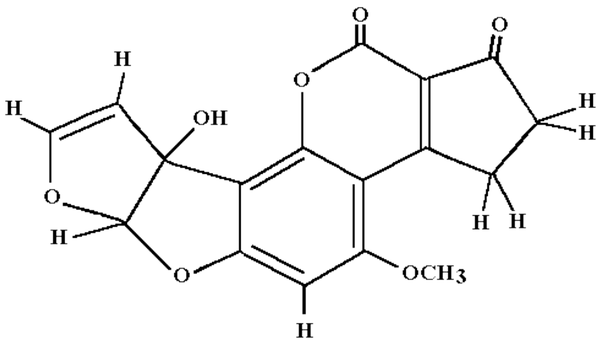
INTRODUCTION

AFLATOXINS



- Genotoxic carcinogens, reproductive toxicants (Szentirmay et al. 2025, *Toxins*), teratogenic and immunosuppressive compounds
- Produced by *Aspergillus flavus*, *A. parasiticus*, and *A. nominus* species
  Food-chain–related issue – economic and health damage

grain contamination → animal welfare → human health



Aflatoxin M1

Relevance of the topic

- Climate change, increasing frequency of extreme weather events
- Spread of filamentous fungi producing mycotoxins

INTRODUCTION

AFLATOXIN IN FOODS

Aflatoxin B1

- Nuts: especially peanuts, almonds
- Grains: corn, wheat, barley and other cereals
- Whole-grain products!!
- Dried fruits: e.g., dried figs and dried apricots
- Plant-based milks, dairy substitutes (almond, soy)
- Spices: e.g., paprika; Hungary, 2004
- Oils: peanut oil and corn oil

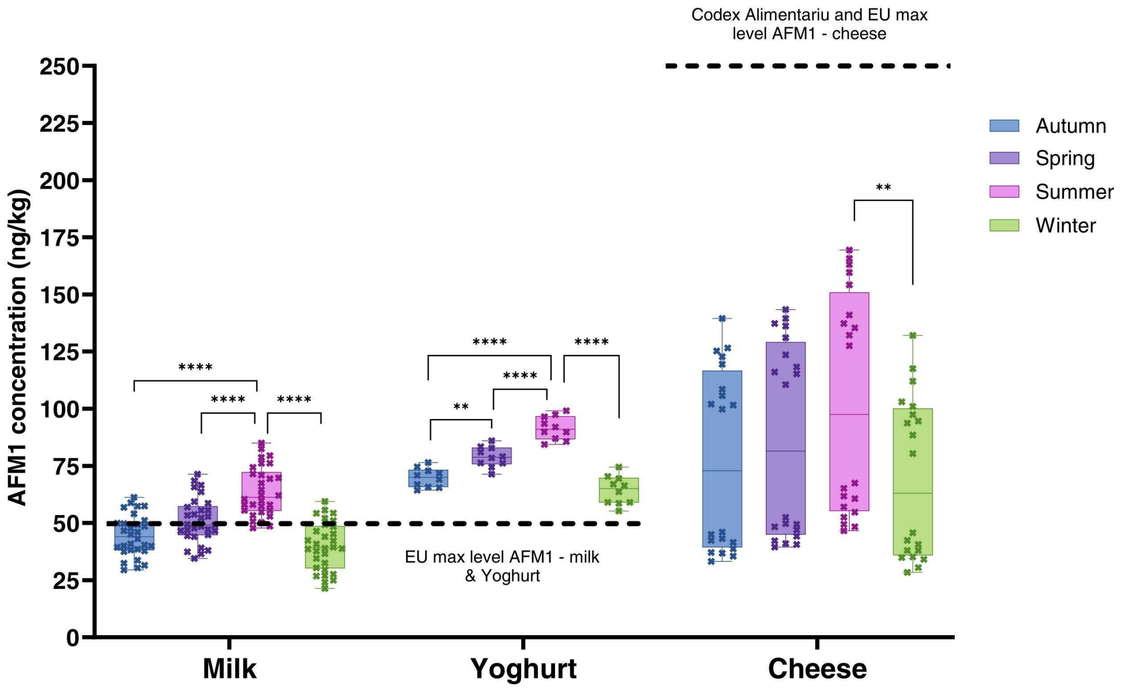
((Meat (liver, kidney), eggs))

INTRODUCTION

AFLATOXIN IN FOODS

Aflatoxin M1

1. **Milk and milk products**
2. (Liver, kidney)



Aghebatbinyeganeh et al. 2024

- Aflatoxin B1 → metabolism → Aflatoxin M1
- Grain to milk carry-over rate: 2-6%

HUMAN HEALTH EFFECTS

- **Aflatoxin B1, M1** (10x less)
- Carcinogenic, liver damage, immune supression, teratogenic

- **Usually long-term adverse effects**
- **Acute toxication is not likely**

SAFE LEVELS??

- **Regulation (EU) 2023/915 on setting maximum levels for certain contaminants in foodstuffs**
  (applies to cereals, oilseeds, dried fruits, dairy products, etc.)

Raw milk, milk used for the production of milk-based products, and heat-treated milk: **0.050 µg/kg**

Infant formula and follow-on formula, including milk-based infant formula and milk-based follow-on formula: **0.025 µg/kg**

MAXIMUM LEVEL ≠ SAFE LEVEL

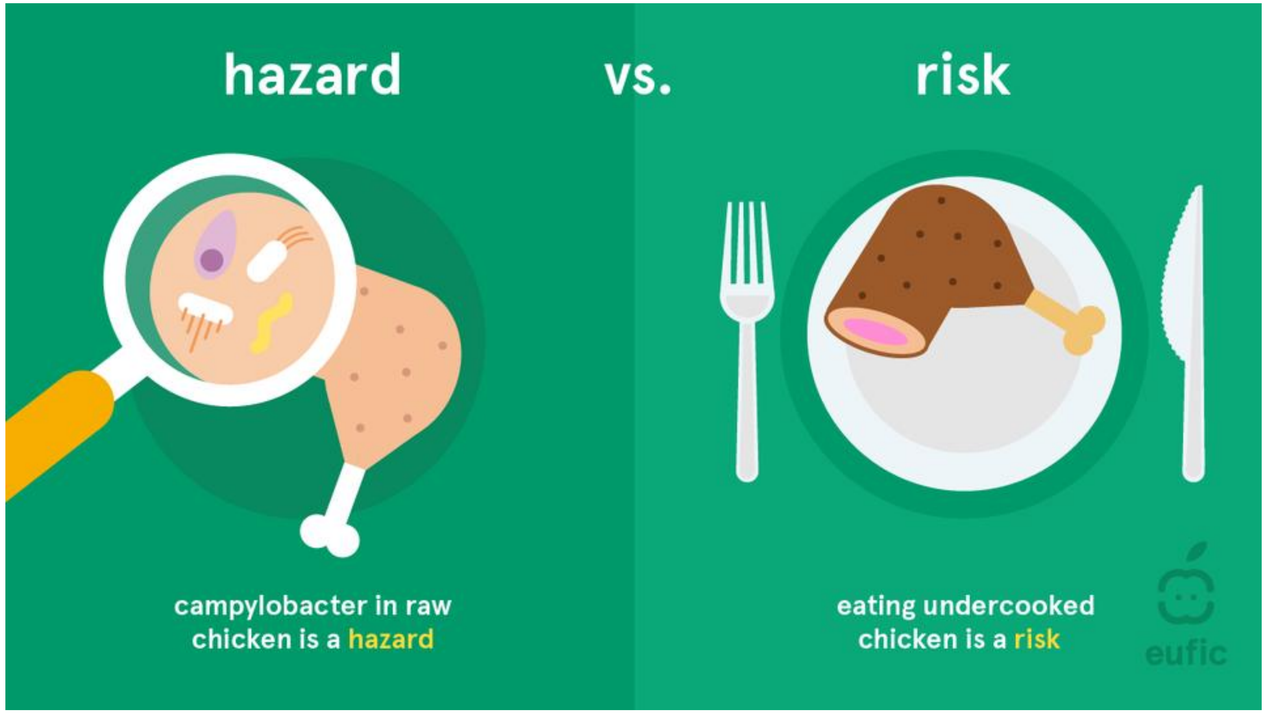
- Carcinogenic compound!

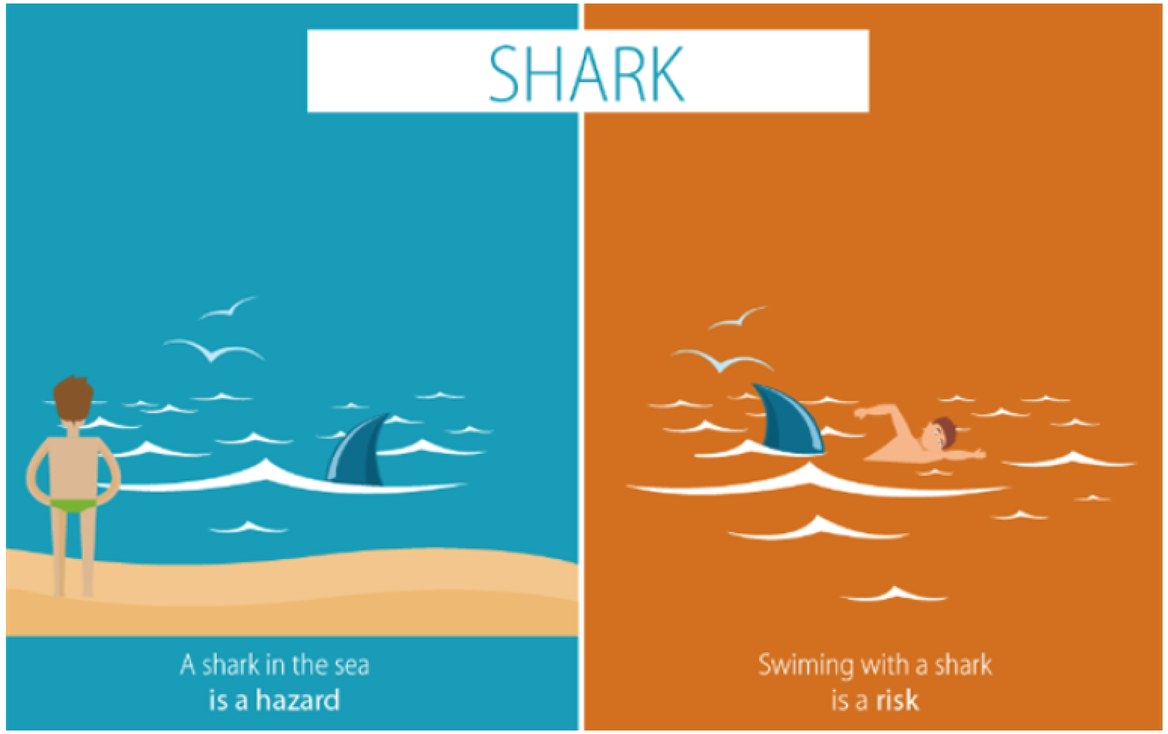
- MLs are based on ALARP principle:
  As Low As Reasonably Practicable

- To assess health risks, toxicological reference values determined from toxicological studies (animal studies) are used, e.g.:
  Acceptable/tolerable daily intake value
  Acute reference dose, etc.

- During risk assessment, exposure is compared to these values.

RISK VS. HAZARD

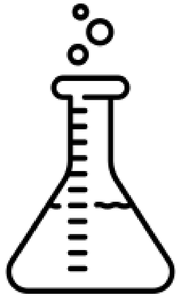




EXPOSURE ASSESSMENT

Exposure = contaminant concentration in food × amount of food consumed (body weight kg/day)

Contaminant data



Consumption data

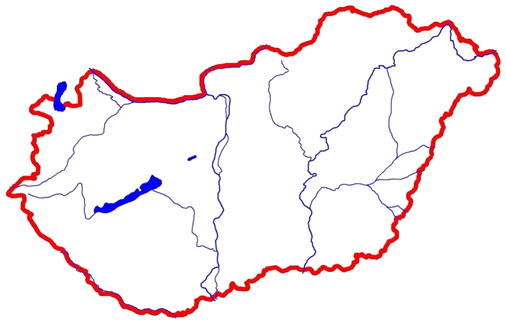
Exposure – Estimated Daily Intake (EDI)

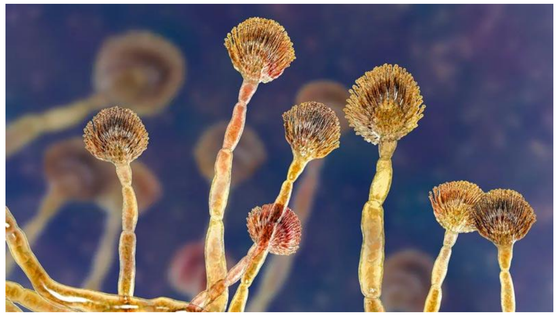
CURRENT SITUATION IN EUROPE

- **European Food Safety Authority (EFSA) risk assessment (2020):**
- **AFB1:** cereals and cereal-based products contribute most to exposure across all age groups – health risk (liver cancer) for all age groups
  AFM1: mainly milk and fermented milk products – health risk for younger consumers
- **AFM1 in cow's milk** – Greece, Albania, Serbia, Italy: risk for multiple consumer age groups (Udovicki et al., 2019; Djekic et al., 2020; Milićević et al., 2021; Topi et al., 2022; Summa et al., 2025 – raw milk!)
- **Plant-based milk study (Gützkow et al., 2024):** Germany – multiple mycotoxins (AFB1), heavy metals – new exposure sources
- **In meat substitutes (Mihalache et al., 2024):** Italy – risk for AFB1 and other mycotoxins

CURRENT SITUATION IN HUNGARY

- The aflatoxin crisis of 2012 drew attention to the fact that the mycotoxin problem caused by climate change also affects Hungary – ***Aspergillus* occurrence studies** (Dobolyi et al. 2013)
- Multitoxin analysis, including aflatoxins, and *Aspergillus* detection in different wheat genotypes: aflatoxin **sometimes exceeds the limit value even when *Aspergillus* fungal infection is rarely detectable** (Berényi et al. 2024)
- **AFM1 in milk (Farkas et al., 2022):** *health risk found for toddlers and young children*, despite only 28% of samples containing detectable amounts and 2% exceeding the limit
- **AFM1 in milk (Buzás et al., 2023):** *no risk reported, but based on average consumption assumptions*, without considering age groups (2 dl milk consumption, 70 kg average body weight), even though 79% of samples contained AFM1 and 9.4% exceeded the limit





AFLATOXIN

RISK-REDUCTION OPTIONS

Difficulties:

- Irradiation of foods is not permitted in Europe
  Often no visible difference between contaminated and uncontaminated maize kernels
  Mycotoxins may be present even when mold growth is not visible
- **In foods?**
  Not or hardly feasible, not realistic
  Heat-stable compound

AFLATOXIN

RISK-REDUCTION OPTIONS - PREVENTION

- **Main topics based on the reviewed publications (Farkas et al. 2022, *Toxins*):**

  - Low moisture content (corn drying methods are effective, but not for whole ears)

  - Preservatives (innovative methods such as essential oils, plant extracts, metal nanoparticles)

  - Acidification (organic acids)

  - Adsorbents

  - Microorganisms and enzymes

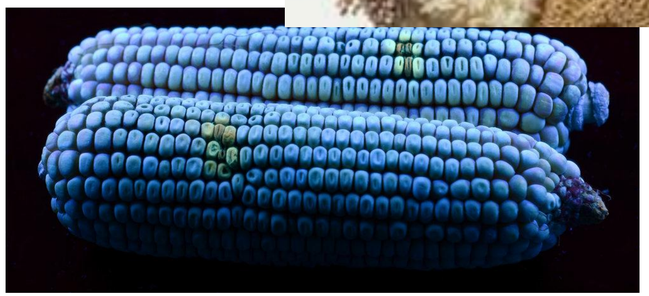
- **Additional examples**

  - Atoxigenic *Aspergillus* strains

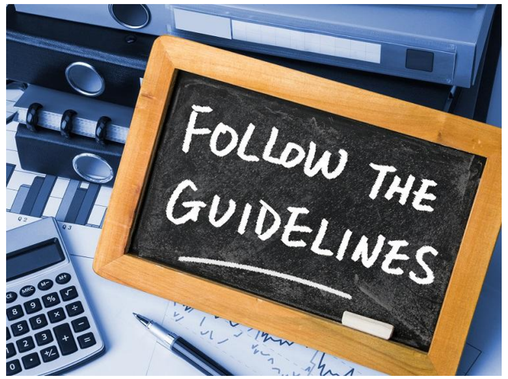
  - Toxin-resistant maize varieties

  - Physical methods (aeration, etc.)

  - UV treatment, irradiation, etc.



WHAT CAN WE DO?



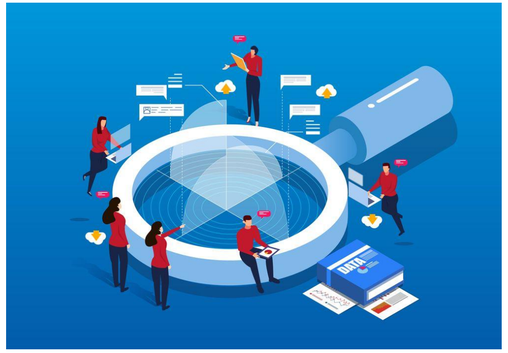
AGRICULTURAL SECTOR

- **Prevention!** Strong emphasis must be placed on reducing *Aspergillus* infection overall, and promoting agricultural, storage, treatment, detoxification, and processing technologies that inhibit mold growth and reduce aflatoxin levels.

AUTHORITIES

- **Regulatory amendments for monitoring!** Introduction of action thresholds below established limit values.

ACADEMIA



- Further coordinated research (contamination levels, consumption surveys, risk assessments)
- **Interdisciplinary approach:** toxicology, food science, data analysis

WHAT CAN WE DO AS CONSUMERS?

- Eating is risky 😊
- Varied diet (risk vs. benefit)
- High-risk groups should avoid foods particularly risky in terms of aflatoxins (e.g., pregnant and breastfeeding women should avoid consuming large amounts of whole-grain products)
- Pay attention to shelf-life and product condition (e.g., musty smell)
- Discard the product if mold is present
- Trust our body’s detoxification mechanisms

THANK YOU FOR YOUR KIND ATTENTION!

E-MAIL:
farkas.zsuzsa@univet.hu

Department of Digital Food Science
https://dfi.univet.hu/