APPLICATION OF MATHEMATICAL MODELS TO MYCOTOXINS CHILDREN RISK ASSESSMENT: A CASE STUDY OF PORTUGUESE CHILDREN EXPOSURE TO CO-OCCURRING MYCOTOXINS IN PROCESSED CEREAL-BASED FOODS

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Background

- People, animals and the environment can be exposed to **single** and **multiple chemicals** at once from a variety of sources.
- Risk assessment is usually carried out based **on one chemical substance at a time**.
- Mycotoxins
  - fungal secondary metabolites that are known to potentially cause **toxicity and carcinogenic** outcomes;
  - commonly found in a variety of foods including those intended for consumption by **infants and young children**, namely in **processed cereal-based foods available in the Portuguese** market[1].
- The use of **mathematical models**, including probabilistic approaches using **Monte Carlo simulations**, constitutes a prominent issue in human health risk assessment.

Aims

- **Characterize**, for the first time, the **risk** associated with the **exposure of Portuguese children** to **single** and **multiple mycotoxins** present in **processed cereal-based foods** (CBF):
  - Food consumption data
  - Contamination data
  - Exposure assessment

  Risk Characterization

Methodologies

- **Food consumption data**

Food consumption data of children (0-3 years old) from Lisbon region (n=103) were collected using a 3 days food diary.

- **Contamination data**

Aflatoxins and ochratoxin A were quantified in 20 CBF samples marketed in 2014 and 2015 in Lisbon. Analysis were performed by HPLC-FLD[1].

- **Exposure assessment**

Daily exposure of children to mycotoxins was performed using deterministic and probabilistic approaches. Different strategies were used to treat the left censored data (mycotoxin levels < limit of detection, LOD)[2].

Results

- **Processed cereal-based foods consumption**
  - Approximately 47% of the studied children consumed CBF at least one time in these 3 days.
  - 27% of consumers were aged < 1 year old and 73% aged between 1 and 3 years old.

- **Contamination of processed cereal-based foods**

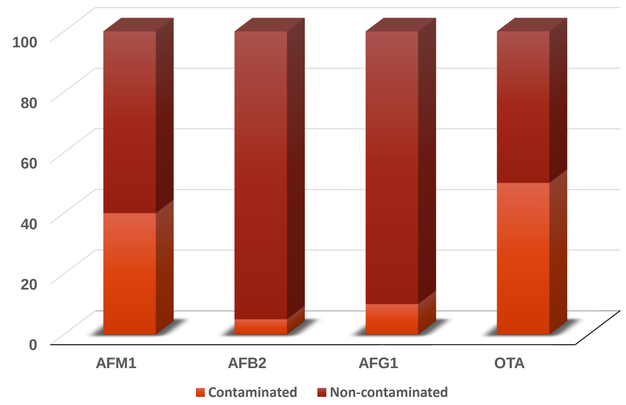

Fig. 1: Percentage (%) of contaminated samples, considering each mycotoxin (n=20).

  - 75% of analyzed CBF were contaminated with, at least, one mycotoxin.
  - OTA presented the highest contamination level.
  - All samples revealed levels of AFB_1 and AFG_2 bellow the LOD value.

- **Exposure assessment & Risk characterization**

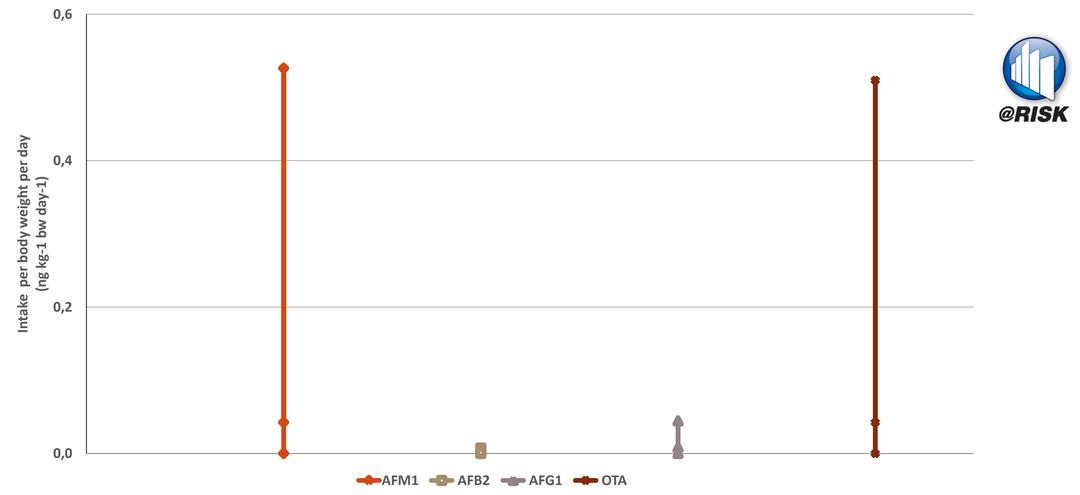

Fig. 2: Results of deterministic (central mark, mean value) and probabilistic approaches (top and down marks for P1 and P99) to estimate children exposure to aflatoxins M_1, B_2, G_1 and ochratoxin A, through ingestion of processed cereal-based foods (ng.Kg^{-1} bw.day^{-1}). Results show fourth scenario (<LOD = uniform distribution with min=0 and max=LOD). Remaining scenarios followed the same pattern.

  - AFM_1 revealed a margin of exposure (MoE) below 10000 suggesting potential health concern for the higher percentiles of intake (≥ P75). MoE of the remaining aflatoxins were above 10000 for all percentiles[3].
  - OTA presented a hazard quotient (HQ) below 1 for all percentiles, suggesting no potential health concern[3].
  - Considering the co-occurrence of aflatoxins, and applying the concentration addition concept, combined margin of exposure (MoET) was below 10000 for ≥ P75 and this fact constitutes a potential health concern[3].

Packaging materials with antifungal properties

Control of moulds growth

Decrease the RISK!

Children are a particularly **vulnerable population group** to food contaminants and the present results point out an **urgent need to establish legal limits and control strategies** regarding the presence of multiple mycotoxins in children foods in order to protect their health. The development of **packaging materials with antifungal properties** is a possible solution to control the growth of moulds and consequently to reduce mycotoxin production, contributing to guarantee the **quality and safety of foods intended for children consumption**.

References:
[1]Alvito et al. (2010). *Food Analytical Methods*, 3: 22–30. [2]European Food Safety Authority (EFSA) (2010). *EFSA Journal,* 8(3): 1557. [3]European Food Safety Authority (EFSA) (2013). *EFSA Journal*, 11(7): 3313. [4]Ruyck, et al. (2015). *Mutation Research*. http://dx.doi.org/10.1016/j.mrrev.2015.07.003

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