

MYCOMIX and risk assessment: a contribute to improve risk analysis

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MYCOMIX



Within **risk analysis**, the **risk assessment** results are quantitative or qualitative expressions of the likelihood of harmful effects associated with exposure to a chemical¹. Human risk assessment of combined exposure to **multiple chemicals (chemical mixtures)** poses several challenges to scientists, risk assessors and risk managers, namely the complexity of the terminology and problem formulation, the diversity of chemical entities, and the toxicological profiles and exposure patterns in test species and humans².

Mycotoxins are natural contaminants produced by fungi and its frequent co-occurrence in food poses a threat to human health, mainly to vulnerable population groups as children. The MYCOMIX project (2013-15) "Exploring the toxic effects of mixtures of mycotoxins in infant food and potential health impact" aims to contribute to fill the gap concerning the **risk assessment of children to multiple mycotoxins in infant foods**. This project aims to answer three questions: **1) Are children exposed daily to one or several mycotoxins through food?, 2) Can this co-exposure affect children's health? and 3) Are there interaction effect between mycotoxins?**

Occurrence data

The occurrence data of 12 mycotoxins (aflatoxins, ochratoxin A, fumonisins and trichothecenes) were quantified in 26 Breakfast Cereals (BC), marketed in 2014 in Lisbon (PT), using HPLC-FLD, GC-MS and LC-MS/MS³.

- 92% (24/26) of the analyzed BC revealed the presence of two to six mycotoxins, simultaneously, in the same sample¹.
- 19% of samples (4/26) were contaminated with six mycotoxins simultaneously³.
- The mycotoxins mixture with highest incidence (3/26) was AFB₁, AFB₂, OTA and DON³.
- Results were all below the maximum legislated limits³.



Consumption data

Infant foods consumption data were obtained in a pilot study including 103 child (0-3 years old) from the Primary Health Care Unit of Cidadela, Cascais. A 3 day food diary was applied and data introduced in a web-based platform - OPEN PORTUGAL⁴. For Breakfast Cereals consumption, a subsample of 75 children aged between 1 to 3 y old was used.

- 56% of children aged 1-3 years old consumed breakfast cereals at least one time in 3 days as reported in the food diary⁵.
- 40% of children aged 1-3 years old presented a mean weight of 13.39 kg and a mean consumption of breakfast cereals of 5.62 g day⁻¹ ⁵.

MYCOMIX

MYCOMIX outputs contribute for hazard identification and characterization, as well as to exposure characterization, thus contributing for risk analysis.

The risk derived from exposure of children to mixtures of mycotoxins in breakfast cereals was assessed, demonstrating that there is a potential health concern towards this vulnerable population. Therefore, a need for further action is necessary namely, by putting in place a monitoring program at national level, in view of establishing legal protective values.

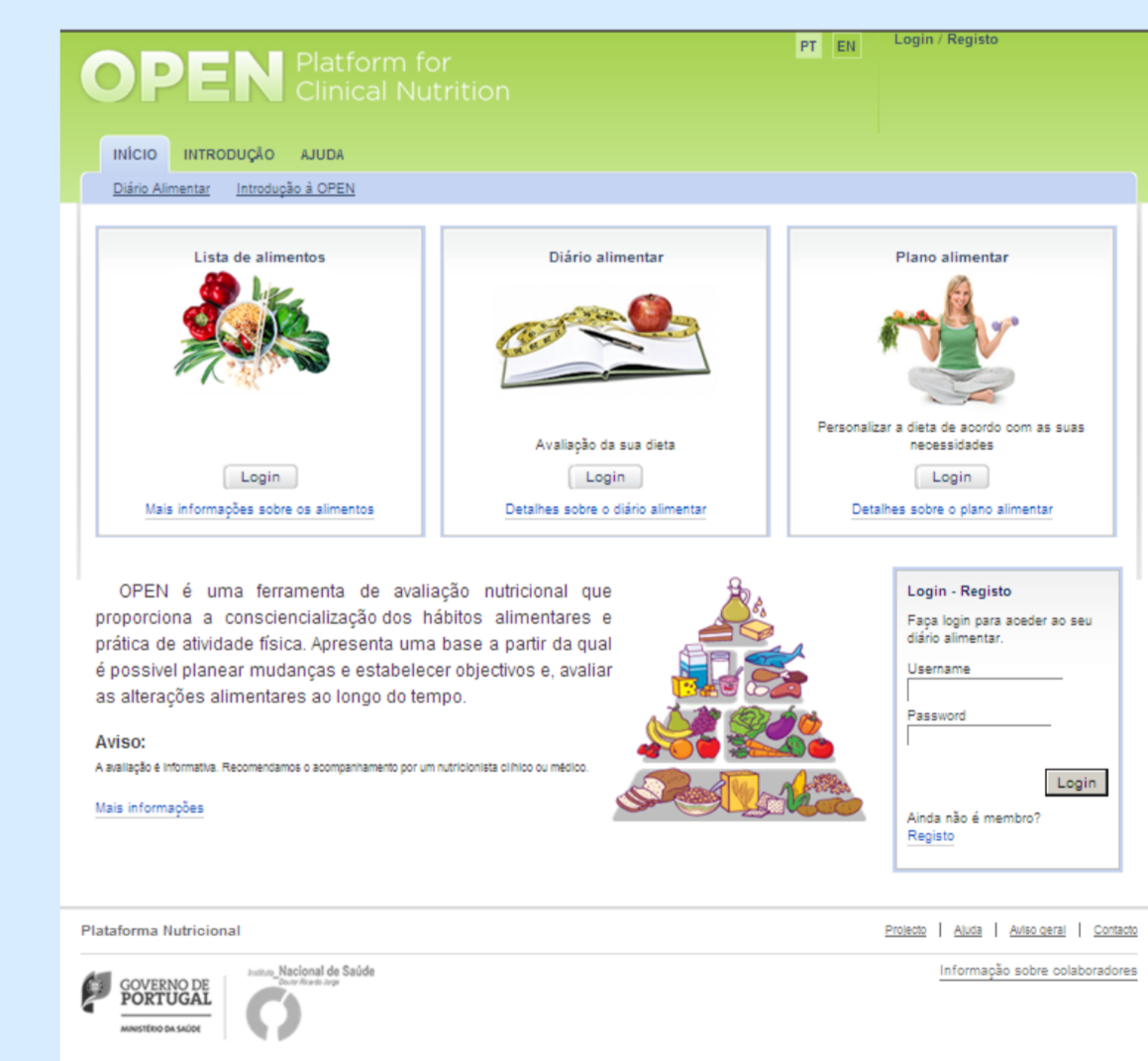


Figure 2 – OPEN Portugal – web-based platform.

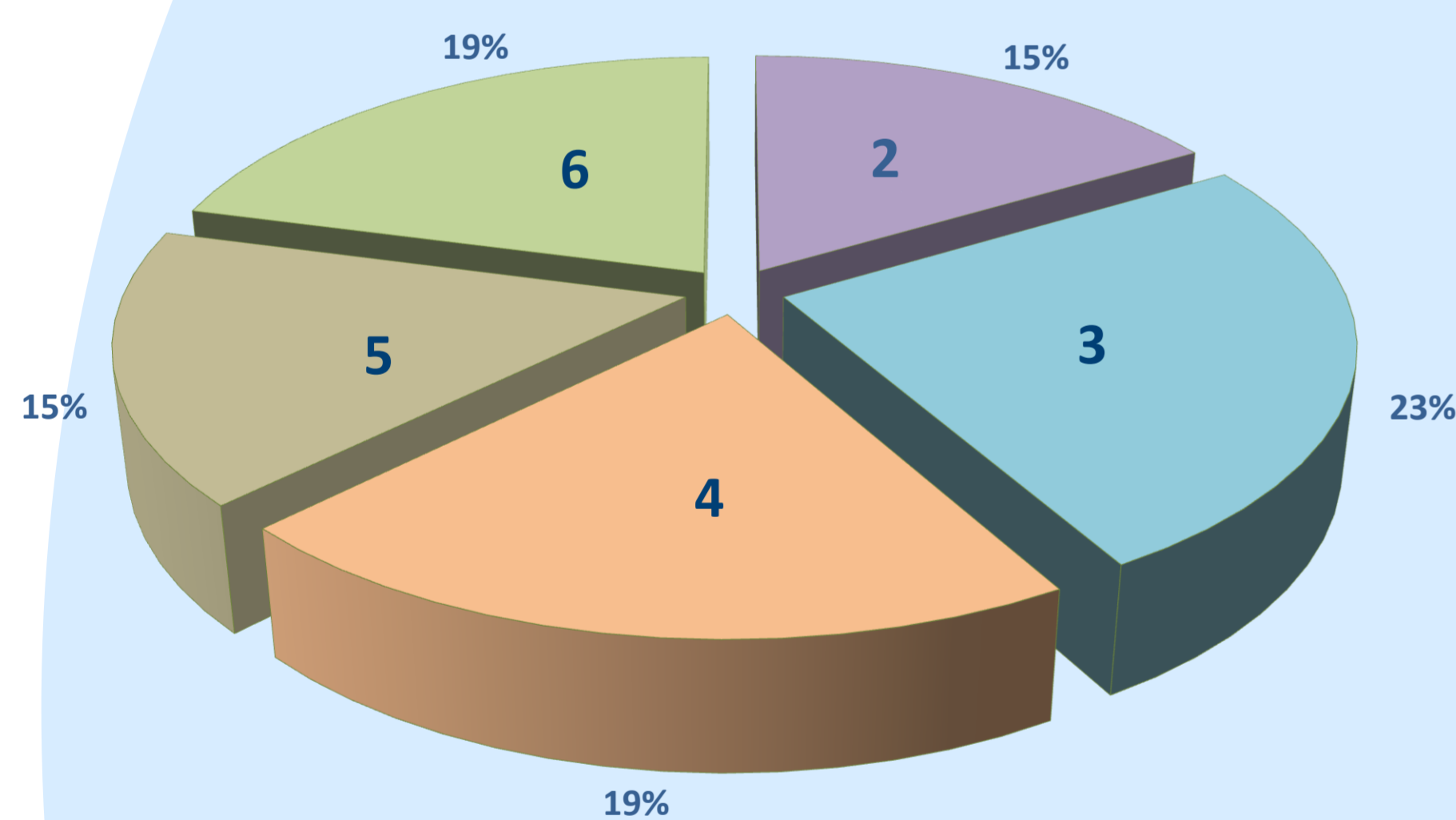


Figure 1 – Co-occurrence of mycotoxins in analyzed breakfast cereal samples, including the number of mycotoxins determined in the same sample (inside the plot) and the respective percentage. Results present only the co-occurrence of 2 or more mycotoxins³.

Toxicological data

Bioaccessibility studies

Harmonized *in vitro* digestion model simulating the human digestion (oral, gastric and intestinal phases) was applied to determine the mycotoxin bioaccessibility.

Bioaccessibility values for single mycotoxins ranged:

- 40 and 72 % for patulin in cereal based foods⁶.
- 86 and 104% for aflatoxin M₁ in infant formulae⁶.

Cito and genotoxicity studies (Caco-2, HK-2, HepG2)

Citotoxicity (neutral red and MTT assays) and genotoxicity (comet assay) of mixtures involving OTA were assessed and interactions between mycotoxins were evaluated using the Concentration Addition and Independent Action Conceptual models.

- The results showed interactive toxic effects between binary mixtures of AFM₁ & OTA⁷ and OTA & FB₁⁸, indicating that these effects should be taken into account for the hazard assessment of mycotoxins.

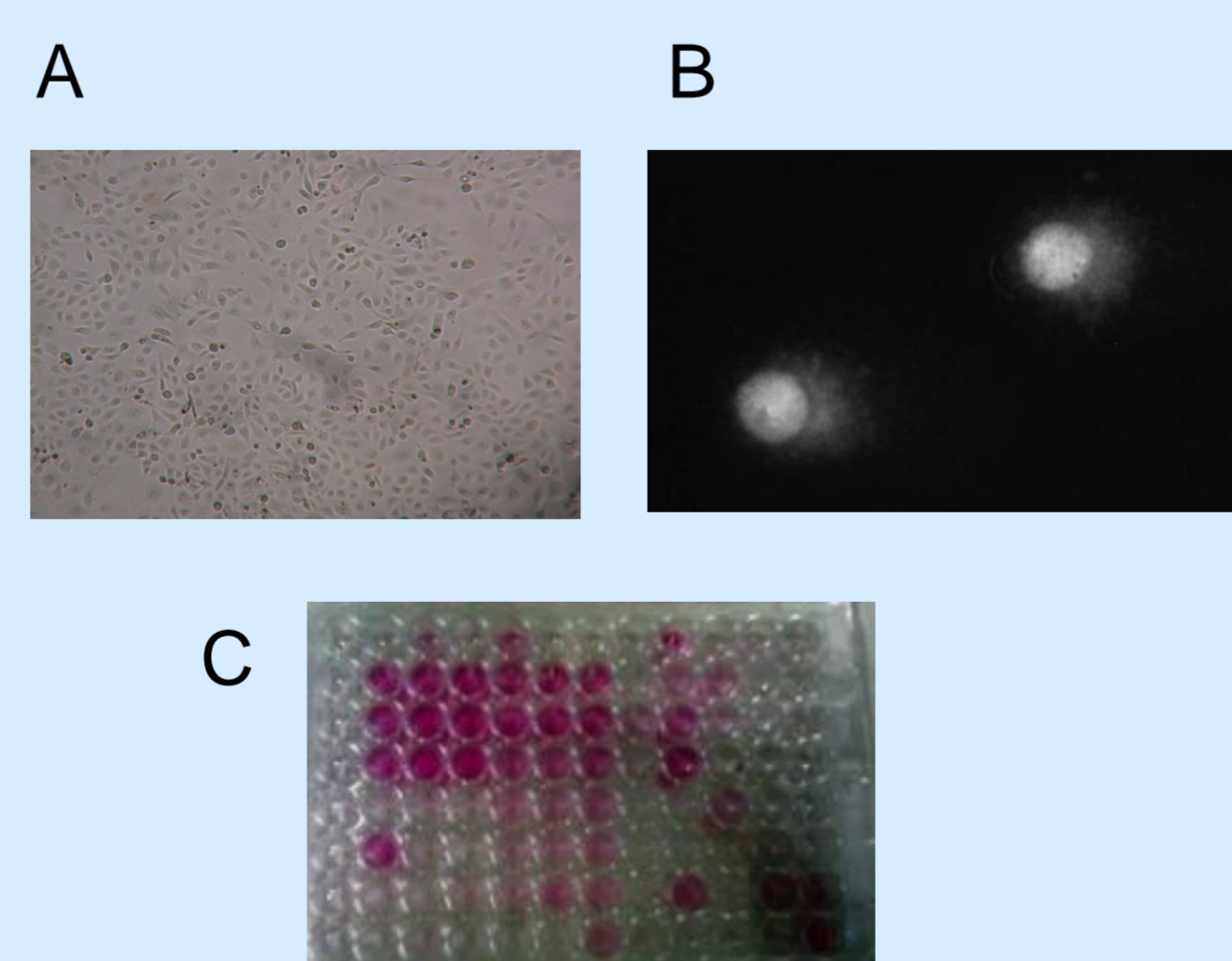


Figure 3 – Microphotographs showing HK-2 cells (A) comet images (B) and illustrating the neutral red assay (C).

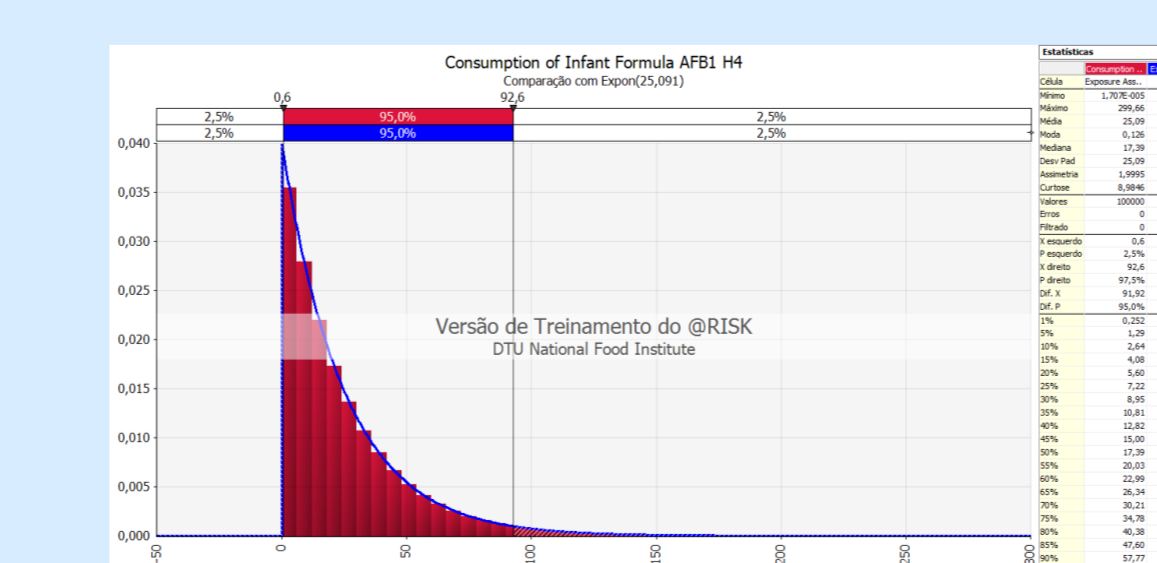


Figure 4 – Probabilistic approach for mycotoxin risk assessment using @RISK software.

Exposure assessment data

Two mathematical approaches: deterministic and probabilistic (Monte Carlo simulation) will be used for the computation of the exposure assessment for mycotoxins.

Different exposure scenarios for the mycotoxin dietary exposure assessment in relation to the data treatment of the non-detects (< LOD, limit of detection) will be included.

- Daily exposure of children to ochratoxin A, fumonisins and trichothecenes showed no health risks to the children population considering individual mycotoxins (hazard quotients below 1)⁵.
- Cumulative risk assessment suggests an urgent need to establish legal limits for multiple mycotoxins in breakfast cereals.