Risk-benefit assessment of cereal-based foods consumed by children – a case study under RB4EU project

Disclaimer

• This study was developed under the “RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach” funded by EFSA Partnering Grants (Grant Agreement Number – GA/EFSA/AFSCO/2017/01 – GA02)

• This study only reflects the authors’ view and EFSA is not responsible for any use that may be made of the information it contains
Outline

• RiskBenefit4EU & Case study

• Cereal-based foods as a source of
  • nutrients &
  • chemical contaminants &
  • microbiological contaminants

• Risk-benefit assessment of cereal-based foods consumed by children in Portugal
RiskBenefit4EU – Partnering to strengthen the risk-benefit assessment within EU using a holistic approach

https://riskbenefit4eu.wordpress.com/
RiskBenefit4EU: objectives

1) To **capacitate** recipient partners on food RBA

2) To develop **RBA tools** that can estimate the overall health effects of foods, food ingredients and diets

3) To develop a **harmonized framework for RBA** that can be applied to data from different countries

4) To validate the generated framework through the application to a **case study**

5) To **disseminate and promote** the harmonized framework to potential **EU users**
RiskBenefit4EU: objectives

1) To capabilitate recipient partners on food RBA

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Risk-benefit assessment of cereal-based foods consumed by children
Cereal-based foods & Children diet

• Cereal-based foods are among the first solid foods to be introduced in children diet
  • Important food group of their diet, contributing for an optimal health (Schwartz et al., 2008; Collins et al., 2010)
    • Essential macronutrients
    • Other important nutrients (e.g. vitamins, minerals, and micronutrients)
    • Levels in the food of certain components

• Vulnerable population → immediate and future impact
Cereal-based foods & ... Nutrients

• Source of several nutrients, including Sodium, Fibre and Free sugars
  • Sodium & free sugars intake: potential deleterious health effects (e.g. CVD, dental caries, etc.)

<table>
<thead>
<tr>
<th>Sodium intake</th>
<th>Free sugars</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO: 2 g/day in adults</td>
<td>WHO: up to 10% of total energy intake*</td>
</tr>
</tbody>
</table>

*Conditional recommendation to reduce intake to below 5% of total energy intake

• Fibre intake: potential health beneficial effects
  • Immediate and future health benefits (e.g. gastrointestinal function; children obesity, CVD, type 2 diabetes, etc.)
Cereal-based foods & Nutrients & ... Chemical contaminants

• Besides the healthy components, cereals could also present potential **risks**, e.g. mycotoxins

• **Mycotoxins** (secondary metabolites of fungi)
  • Cereals are one of the most important food commodity contaminated by mycotoxins
  • If they are present in foods usually consumed by children → meticulous attention!
Mycotoxins in cereal-based foods usually consumed by children in Portugal

Food and Chemical Toxicology 118 (2018) 399–408

Contents lists available at ScienceDirect

Food and Chemical Toxicology

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

Portuguese children dietary exposure to multiple mycotoxins – An overview of risk assessment under MYCOMIX project

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Portuguese children exposure to multiple mycotoxins

- 94% of cereal-based products were contaminated with at least one mycotoxin
- Aflatoxins exposure suggested potential adverse health effect for P50 or higher

Risk characterization using MoE and MoET derived from estimates of aflatoxin exposure from different food products, performed by probabilistic approach (H1 scenario: < LOD = LOD).
Cereal-based foods & Nutrients & Chemical contaminants & ... Foodborne pathogens

• Usually cereal-based foods consumed by children present low $a_w \rightarrow$ low moisture foods (e.g. breakfast cereals)
  • Long shelf-life
  • Public perception/not presenting microbiological risks
  • However… some microorganisms

Could persist for long periods of time
Could present low infectious dose
Could grow due to temperature abuse (e.g. *Bacillus cereus*)
Cereal-based foods consumed by children in Portugal – important considerations

• Young children (1-3 years old) are eating cereals (breakfast cereals) not particularly intended to be eaten by that age group
Cereal-based foods consumed by children in Portugal – important considerations

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- **Regulation** of these products (breakfast cereals) not designed and established considering the **specific vulnerability** of this population group
Cereal-based foods consumed by children in Portugal – important considerations

- Young children (1 - 3 years old) are eating cereals (breakfast cereals) not particularly intended to be eaten by that age group.

- Regulation of these products (breakfast cereals) not designed and established considering the specific vulnerability of this population group.

- Other cereal-based products (infant cereals) in principle most adequate and presenting available regulation, adequately developed taking into consideration the age group of the target consumers.
Cereal-based foods & Risk-benefit assessment

1) To validate the generated framework through the application to a case study (RB4EU objective)

2) To assess the risks and the benefits associated to the consumption of cereal-based products usually consumed by the Portuguese young children
• Follow the stepwise approach of RB4EU
• Gather data needed to perform the RBA
• Model & calculations
Risk-benefit question

• What would be the health impact of replacing the consumption of breakfast cereals by infant cereals usually consumed by the Portuguese children aged between 6 and 35 months, comparing to the current situation concerning aflatoxins, *Bacillus cereus*, fibre, sodium and free sugars?
# Scenarios

<table>
<thead>
<tr>
<th># Scenario</th>
<th>Description 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>Current cereal-based products consumption</td>
</tr>
<tr>
<td>1</td>
<td>100% Breakfast cereals consumption (substitution of IC by BC) 1</td>
</tr>
<tr>
<td>2</td>
<td>100% Infant cereals consumption (substitution of BC by IC) 1</td>
</tr>
<tr>
<td>3</td>
<td>Best BC: all cereals consumption was replaced by a specific breakfast cereals product 2</td>
</tr>
<tr>
<td>4</td>
<td>Worst IC: all cereals consumption was replaced by a specific infant cereals product 2</td>
</tr>
</tbody>
</table>

1 Randomly selected based on the distribution of the consumption of these products in the population

2 Products defined using a score, using the 3 nutritional components [fibre (+), sodium (-) and free sugars (-)]. Best BC → Highest score; Worst IC → Lowest score.

3 Amount consumed: substitution preserved the same amount of calories (isocaloric).
Identification of relevant food components, health effects and prioritization

1. “Food-compound” literature search → to identify the components of interest for the food products considered

2. “Compound-health effect” literature search → to identify the health effects associated to a specific food component
Relevant food components & health effects

**Nutrition**

- Food components:
  - Fibre (quantitative analysis)
    - Type 2 Diabetes mellitus
    - CVD
  - Sodium (semi-quantitative analysis)
  - Free sugars (semi-quantitative analysis)

**Toxicology and Microbiology**

- Food components:
  - Toxicology: Aflatoxins – AFB$_1$
    - Hepatocellular carcinoma (HCC) → pivotal effect for the risk assessment (EFSA, 2007)
  - Microbiology: *Bacillus cereus*
    - Gastrointestinal disease (foodborne)
Data sources used

- Chemical contaminants (Mycotoxins)
- Microbiological contaminants
- Consumption data: information on food consumption

Additional data sources:
- Published data
- GBD Results Tool
Exposure assessment & Risk and Benefit characterization & Integration

- Consumption of BC and IC
  - Calculated for each scenario
  - SPADE software
- Risk and Benefit characterization:
  - RR and PIF
- Integration of Risks and Benefits
  - DALYs calculation
  - ΔDALY
Results:
Microbiology

• Despite it is expected that *B. cereus* could be present in these cereal-based products, modelling results suggested that the occurrence of cases of disease due to this microorganism is negligible

• Not considered further in the assessment!
## Results:
Consumption of BC & IC according to the different scenarios; Exposure assessment

### Mean consumption of BC, IC for the different scenarios considered

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>100% BC</th>
<th>100% IC</th>
<th>Best BC</th>
<th>Worst IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC (g/day)</td>
<td>3.3</td>
<td>17.2</td>
<td>0.0</td>
<td>18.2</td>
<td>0.0</td>
</tr>
<tr>
<td>IC (g/day)</td>
<td>13.0</td>
<td>0.0</td>
<td>16.3</td>
<td>0.0</td>
<td>17.2</td>
</tr>
</tbody>
</table>

### Fibre, sodium, free sugars and aflatoxins intake, considering the different scenarios

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>100% BC</th>
<th>100% IC</th>
<th>Best BC</th>
<th>Worst IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre, mean (g/day)</td>
<td>9.3</td>
<td>9.5</td>
<td>9.2</td>
<td>11.4</td>
<td>8.9</td>
</tr>
<tr>
<td>Sodium, mean (mg/day)</td>
<td>1190</td>
<td>1204</td>
<td>1185</td>
<td>1168</td>
<td>1201</td>
</tr>
<tr>
<td>Free sugars, mean (g/day)</td>
<td>20.5</td>
<td>20.9</td>
<td>20.4</td>
<td>17.1</td>
<td>19.9</td>
</tr>
<tr>
<td>Aflatoxins, mean (ng/kg bw/day)</td>
<td>0.065</td>
<td>0.073</td>
<td>0.065</td>
<td>0.052</td>
<td>0.090</td>
</tr>
</tbody>
</table>
### Results: Risk characterization

Risk characterization regarding Type 2 Diabetes Mellitus, Cardiovascular Diseases, Hepatocellular carcinoma, considering the different scenarios

<table>
<thead>
<tr>
<th>Type</th>
<th>Reference</th>
<th>100% BC</th>
<th>100% IC</th>
<th>Best BC</th>
<th>Worst IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2 Diabetes Mellitus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases prevented, by 100k/year</td>
<td>-</td>
<td>-0.714</td>
<td>0.211</td>
<td>-6.618</td>
<td>1.272</td>
</tr>
<tr>
<td>Cardiovascular Diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cases prevented, by 100k/year</td>
<td>-</td>
<td>-0.160</td>
<td>0.047</td>
<td>-1.469</td>
<td>0.288</td>
</tr>
<tr>
<td>Hepatocellular carcinoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of extra cases/100k due to aflatoxin exposure</td>
<td>-</td>
<td>0.00073</td>
<td>0.00065</td>
<td>0.00052</td>
<td>0.00090</td>
</tr>
</tbody>
</table>
Results: DALYs – Risks & Benefits

Health impact of the different alternative scenarios comparing to the reference scenario, expressed in DALYs/100,000.
Results: Integration of Risks & Benefits

ΔDALY resulting from the integration of several domains.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>ΔDALY</td>
<td>-0.486</td>
<td>0.143</td>
<td>-4.473</td>
<td>0.877</td>
</tr>
</tbody>
</table>
Prevalence of inadequate intake of sodium and free sugars, considering the different scenarios (semi-quantitative approach).

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>100% BC</th>
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<tbody>
<tr>
<td>Sodium (UL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1500 mg/day</td>
<td>24.8%</td>
<td>25.7%</td>
<td>24.3%</td>
<td>23.4%</td>
<td>25.4%</td>
</tr>
<tr>
<td>Free sugars (RI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 5% TEI</td>
<td>80.0%</td>
<td>81.9%</td>
<td>79.8%</td>
<td>69.7%</td>
<td>79.0%</td>
</tr>
<tr>
<td>&gt; 10% TEI</td>
<td>29.4%</td>
<td>31.6%</td>
<td>29.2%</td>
<td>16.0%</td>
<td>27.7%</td>
</tr>
</tbody>
</table>
Main thoughts from the outputs

1. Substitution of the current consumption of Breakfast cereals and Infants Cereals by the Portuguese children (under 3 years old) could represent a gain in healthy-life years
   - Current scenario $\rightarrow$ 100% BC & Best BC
   - To “Best BC”: improvement also in the % of the inadequate intake of Sodium, Free sugars; slight improvement also related with aflatoxins exposure
   - “Best BC”: Adoption by the consumers, by this age group, is questionable (High fibre; Low sodium and free sugars $\rightarrow$ low palatability)
Main thoughts from the outputs

1. Substitution of the current consumption of Breakfast cereals and Infants Cereals by the Portuguese children (under 3 years old) could represent a gain in healthy-life years
   • Regulation of aflatoxins in BC → not consider stricter limits comparing to infant cereals
   • Independently of the potential benefits, aflatoxins should ALARA
   • If aflatoxins contamination could be reduced, consumers could profit from the benefits presenting by cereal-based foods
Main thoughts from the outputs

2. Framework developed under RB4EU project was successfully used to the risk-benefit assessment of cereal-based foods consumed by children in Portugal
Thank you for your attention!