Microplastics in the food chain: risk characterization for human health and prevalence

Bavo De Witte et al.

13th Symposium of the Scientific Committee of the Belgian Food Safety Agency
Macro/meso/micro/nano-plastics

Definitions are source dependent

- **macroplastics**: > 25 mm
- **mesoplastics**: 5 mm – 25 mm
- **microplastics**: 0.1 µm – 5 mm
- **nanoplastics**: 0.001 µm – 0.1 µm
Occurrence of microplastics in food

Want some plastic particles with that cold

Public health could be 'at risk' from exposure to microplastics in drinking water

A new report from the Environmental Protection Agency delves into the source of microplastics in our waters. You can even drink contaminated

British mussels for microplastics

Thursday, October 13, 2017 by Russell Davis

The Telegraph

Science

Seafood eaters ing pieces of plastic eyeshows

Is zeezout een plastiekbom?

In het nieuws

Zeezout wordt aangerezen als een gezonder alternatief voor klassiek tafelzout. Nieuw onderzoek toont echter aan dat de zoutkorrels een bron van plastiek op je bord zijn.

Waar komt dit nieuws vandaan?

De vervuiling van onze zeeën en oceanen met plastiek is een vrij nieuw onderzoeksterrein.
Occurrence of microplastics in food

Uptake from contaminated environment: water, air

GLOBAL RELEASES TO THE WORLD OCEANS:
CONTRIBUTION OF DIFFERENT PATHWAYS TO THE RELEASE OF MICROPLASTICS

Package contamination

Food processing

Horton et al., 2017
Occurrence of microplastics in food

- **2-4 µplastics/10 g**
- **20-100 µplastics/10 g**
- **14 out of 15 brands <20 µplastics/100 g**
- **15 brands >50 µplastics/100 g**

De Witte et al., 2014; Van Cauwenberghe & Janssen, 2014; Li et al., 2015; Devriese et al., 2017; Yang et al., 2015
Microplastic determination

Sampling
Sample preparation

Extraction

Filtration

Confirmation

Detection
Microplastic determination

Issue 1: background contamination

Solvent contamination

Air contamination

Glassware contamination
Microplastic determination

Issue 2: extraction procedure

Acid digestion

\[ \text{HNO}_3, \text{HClO}_4, \text{HCl}, \ldots \]

65% \( \text{HNO}_3 \), 24 h at room temperature, 2 h at 60°C

Low density polyethylene

Dehaut et al., 2016

Polylauryllactam

Dehaut et al., 2016
## Microplastic determination

### Issue 2: extraction procedure

<table>
<thead>
<tr>
<th>Category</th>
<th>Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid digestion</td>
<td>HNO$_3$, HClO$_4$, HCl, ...</td>
</tr>
<tr>
<td>Oxidizing agents</td>
<td>H$_2$O$_2$, K$_2$S$_2$O$_8$, ...</td>
</tr>
<tr>
<td>Enzymatic agents</td>
<td>Proteinase K, Colorase 7089, ...</td>
</tr>
<tr>
<td>Alkaline agents</td>
<td>KOH, NaOH, ...</td>
</tr>
</tbody>
</table>

- Optimal extraction procedure is matrix dependent
Microplastic determination

Issue 3: microplastic confirmation

Algae

Crystals

Metal

Source: Meri, Guide for microplastic identification
Microplastic determination

Issue 3: microplastic confirmation

Fast, unexpensive
  e.g. hot needle test

Source: Meri, Guide for microplastic identification
Microplastic determination

Issue 3: microplastic confirmation

Accurate confirmation by FT-IR, Raman,...

Fluorescent staining

Maes et al., 2017
Microplastic determination

Issue 4: quality control

Procedure blanks

- LOD, LOQ

E.g. Procedure blank + 3x SD
(De Witte et al., 2014)

Positive control samples

Method validation:
method cut-off, precision, accuracy, robustness,...

Proficiency testing schemes

- Wefta, Quasimeme, others?

Coming soon?
Health effects

Diet — Microplastics — Environment

Ingestion — Environment — Inhalation

Exposure Levels

Bioaccumulation Potential

Particle effects, chemical effects, microbial effects

Write and Kelly, 2017
Health effects

1. Particle effects

Endocytosis by M-cell

Plastics < 10 µm

Write and Kelly, 2017
Health effects

1. Particle effects

Persorption

Plastics < 130 µm

Write and Kelly, 2017
Health effects

1. Particle effects

- Laboratory toxicity test on marine species: effects on gut epithilium, immune system, inflammation, fibrosis, cell damage

- Human toxicity: lack of experimental data on toxicity of microplastics after oral uptake
Health effects

2. Chemical effects

Plastic related compounds
- Building blocks
- Antioxidants + degradation
- UV absorbers
- Degradation products
  - > 200 compounds identified

Environmental contamination
- Sunscreen agents
- Ink components
- Pesticides
- Cosmetics

Biofilm and algae compounds
- Monoterpenes
- Steroids

PAHs and derivatives
- Alkylated PAHs
- Oxygenated PAHs

Oxygen containing aliphatic compounds
- Alcohols
- Fatty acids
- Dicarboxylic acids

Alkylated phenyl benzenes

Gauquie et al., 2015
2. Chemical effects

- What happens to chemicals sorbed to microplastics
- E.g. PCB exposure to Norway lobster

Devriese et al., 2017
Health effects

2. Chemical effects

**500-600 \( \mu \text{m} \) Polystyrene**

- Increase: + Control
- NO Increase for loaded spheres!!

**500-600 \( \mu \text{m} \) Polyethylene**

- Increase: + Control
- Increase for loaded spheres!!

Devriese et al., 2017
2. Chemical effects

- 3 possible scenario’s
  - Ingestion enhances bioaccumulation and toxicity
    (Rochman et al., 2013)
  - Binding reduces bioaccumulation and toxicity
    (Beckingham and Ghosh, 2016)
  - Chemical transfer from plastics to organisms is negligible compared to other exposure routes
    (Koelmans et al., 2016)
3. Microbial effects

- Microbial community on plastics
  - NGS-amplicon sequencing – family level
Health effects

3. Microbial effects

• Potential pathogens present
  - *Bacteroides thetaiotamicron*
  - *Escherichia coli*
  - *Shewanella putrefaciens*
  - *Bacillus cereus*
  - *Aliivibrio wodani*
  - *Stenotrophomonas maltophilia*
  - ...

• Relevance to food? Effect on human health?

De Tender et al., 2015
Conclusions

Prevalence of microplastics in food

- Environmental contamination versus contamination by food processing or food package
- Quality issues within analytical procedures
- Standardization in progress

Risk characterization

- Particle effects, chemical effects, microbial effects
- Lack of experimental data to evaluate human toxicity
Thank you for your attention
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- Karen Bekaert
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