Seafood environmental pollution of micro and nanoplastic particles

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Established November 1, 2002

- statutory public law institution
- portfolio of the Federal Ministry of Food and Agriculture

Independent ...

- in its scientific assessments
- in its research
History of BfR

Imperial Health Office (1876-1919)
„Reich Health Office“ (1919-45)

Federal Health Office (1952-1994)
Federal Institute of Consumer Health Protection and Veterinary Medicine (1994-2002)

August 6, 2002

Law on the reorganization of consumer health protection and food safety

Risk Assessment

Risk Management
Biological and Chemical Safety of Food, Feed & Consumer Products
Fields of Competence

- Food Safety
- Biological Safety
- Safety of Pesticides
- Safety in the Food Chain
- Safety of Chemicals & Consumer Products
- Exposure Assessment
- Risk Communication
- Experimental Toxicology & ZEBET
Why Micro Plastic Particles (MPP)?

Increasing Attention!

- Identified issues on:
  - environment (e.g. visible macro litter)
  - marine animal health (sea birds, fish, crustacea, plankton, …)
  - human health?

Caused by macro-, micro-, nano- scale plastic particles

Impact on food chain?
Increasing attention in national and international institutions

e.g.…. 

**EREN** - EFSAs Emerging Risk Exchange Network (annual report 2013)
The fate of substances in or attached to plastic soup particles and consumed by marine organisms is unknown.

- Do they migrate to the edible parts of fish and shellfish and accumulate there?
- Could there be an associated emerging food safety issue?

**UNEP** – United Nations Environment Programme
In the UNEP Year Book 2014 - emerging issues update “Plastic Debris in the Ocean”

- Concern is growing that MPP could present a threat to marine life, including the pathway for the transport of harmful chemicals through the food web.
- The evidence is still insufficient to quantify the nature and full extent of the effects of MPP.
Increasing attention in national and international institutions

e.g. …

GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection


Recommendations to improve a future assessment:

- Include particles in the nano-size range.
- Evaluate the potential significance of plastics and microplastics as a vector of chemical transport into marine organisms.
- Address the chemical risk posed by ingested microplastic in greater detail.
Open questions concerning MPP

**Relevance**
- Environment
  - Consumer, Humans, Fauna
- Compartment (Water, soil, air, nutrition)

**Sources**
- Plastic waste
  - Secondary
    - Textiles
  - Primary
    - Cosmetics
- Other...?

**Effects**
- Accumulation?
- Where: Tissue? Organs? cell nucleus?
- Acute / Long term effect?

**Methods**
- Identification
- Quantification
- Toxikologic examinations
- Standardisation?

**Measures**
- Definition?
- Regulation? (e.g. content, release)
- Restrictions? (e.g. in cosmetics)
- Size - Nano?

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Sandra Wagener, 2015-11-25, Workshop “Seafood and emerging food safety issues”
Possible contamination of seafood with micro- or nanoplastic

Possible occurrence of (primary) MPP in products (e.g. cosmetics), development of Analytical methods for the identification of MPP (FTIR, ToF-SIMS, pyrolyse GC-MS)

Verification of uptake in mussels

Experimental toxicology & ZEBET
MPP in Seafood – Status of Knowledge

Numerous reviews and reports on the occurrence of MPP in marine and freshwater organisms …

e.g.


• …
MPP in Seafood – Status of Knowledge

Ingestion

● MPP are ingested by a large variety of marine taxa, e.g. fish, mussels…

● Occurrence is reported from all oceanic regions (Boerger et al. 2010, Jantz et al. 2013, Lusher et al. 2013…)

● Occurrence of MPP in 1 % to 12% of investigated species for herring, cod, whiting, haddock, horse mackerel in the North Sea (Foekema et al. 2013)

● Occurrence of MPP in the gut in 4% to 29% of investigated species for cod, grey gurnard, lesser spotted dogfish, saithe, whiting in North Sea, Channel, Irish Sea (Pinnegar 2014)

● Occurrence of plastic particles in 29% to 52% of investigated species of whiting, blue whiting, atlantic horse mackerel, poor cod, John dory, red gurnard in Plymouth, UK (Lusher et al. 2013)
MPP in Seafood – Status of Knowledge

Uptake and passage into tissues / cells

- Very few studies available, in most cases for filter feeding mussels
- Evidence of MPP moving from gut to the circulatory system and deposition in the tissue (Browne et al 2008).

Exposure / Potential effects on humans

- Annual dietary exposure for European shellfish consumers up to 11,000 particles / a (Cauwenberghe and Janssen 2014)
- Contamination of consumption mussels and wild mussels from Belgian department stores and Belgian quaysides varied from 2.6 to 5.1 fibres/10 g (De Witte et al. 2014).
- Maximum concentration of 105 particles g⁻¹ dry weight in wild mussel from the Dutch coast (Leslie et al. 2013)
- Evidence of exposure of humans through their diet: presence of microplastics in seafood could pose a threat to food safety (Van Cauwenberghe and Janssen 2014).
BfR activities on MPP in (sea)food

BfR Opinion No. 013/2015 of 30 April 2015: Microplastic Particle in Food

...Due to a lack of robust data, a health risk assessment of the consumption of food contaminated with microplastic particles is presently not possible. The BfR has requested the European Food Safety Authority (EFSA) for a scientific opinion on the occurrence of microplastic and nanoplastic particles in food, especially in seafood.
**Background of the BfR request to EFSA**

December 2012: Initial literature study - some conclusions:

- Experimental studies support MPP intake by marine organisms (detected in digestive tract), no studies identified so far on detection of MPPs in edible tissues of fish and crustacean

- Sorption and potential accumulation of environmental contaminants (e.g. PAH, Dioxins, PCB) by MPPs is possible

- MPPs principally could serve as a transport vehicle for the transfer of contaminants into marine organisms

- No insights in amounts of intake and on contaminant levels in fish caused by this mechanism

- No information on impact on human health

Scientific research gaps must be identified
Research questions need to be defined
Background of the BfR request to EFSA - chronology

- **02/2013**: Initial request  
  “Scientific opinion concerning the evaluation of MPP in marine animals”

- **02/2014**: 63rd CONTAM panel meeting  
  An extensive literature search shall be undertaken

- **09/2014**: 67th CONTAM panel meeting  
  Discussion of the literature search results with experts in the field

- **12/2014**: EFSA proposal for modified Terms of Reference  
  “Provision of a scientific opinion on the presence of plastic microparticles and nanoparticles in food, in particular seafood”

- **01/2015**: BfR agreed to the modified Terms

- **09/2015**: 1st “meeting” of EFSA Working Group
BfR activities on MPP in (sea)food

FAQs about MPP

Information on…

- MPP in cosmetics
- MPP in food and seafood
- Analytical methods for the identification and quantification of MPP
- …
BfR activities on MPP in (sea)food

Decree of Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety about MPP in food

... in honey, beer and mineral water

... in aquatic organisms

Literature study about intake / uptake and release of MPP:

- Verification of MP in mussels (2 #/g) along the french-belgian-dutch coast (Hollmann et al. 2013)
- Verification of fibrous MP in mussels (2,6 – 6,1 #/ 10g) in North Sea and in trade (De Witte et al. 2014)

→ In most of the studies no identification of plastic type
BfR activities on MPP

Expert Meeting on MPP – July 2014

Summary / Questions:

- 50 Experts from 11 Federal Research Institutions
- Definition is needed (which material(s), scale, …)
- Route of Exposure needs to be specified (environment, food, consumer products)
- Macro-, micro-, nano-scale plastic particles cause different issues and questions
- Do MPP accumulate in humans / animals?
- Do MPP cause toxicological adverse effects? If so, what are the crucial components?
- Development of analytical methods for relevant matrices is crucial
- Improvement of communication between the responsible agencies and extension of research activities
MPP in mussels

Mussels are filter feeder of planktonic particles and might be exposed to MPP in sediments or suspended in sea water

Currently data are insufficient for risk assessments about:

- Uptake, elimination and accumulation of MPP in mussels
- Effects of different particle sizes and particle shapes
- Effects of MPP as carrier for chemicals and pathogens

Standardised polystyrene particles (size 5 & 10 µm)

Multiple shapes of MPP in shower peeling
BfR activities on MPP – experimental approach

Establishment of test protocol to assess uptake and elimination dynamics of MPP in blue mussels

1. Exposure of mussels in static water under controlled conditions for 32 hour $\rightarrow$ Reduction of MPP in water indicate uptake in mussels
2. Transfer of mussels into clean water for 24 h $\rightarrow$ Increase of MPP in water indicate excretion of MPP

Results pre-trial:
Exposure with $5 \times 10^4$ MPP/ml of 5 µm size

- Exponential decline of MPP in water with steady state after 6 hours at 25% of initial exposure concentration $\rightarrow$ substantial uptake of MPP into mussel
- In clean water: Slow excretion of MPP $\rightarrow$ retention of MPP in mussel in short terms in digestive tract, gills and digestive gland
  $\rightarrow$ Need for long-term investigations for excretion dynamics with realistic MPP concentrations
  $\rightarrow$ This method is a passive approximation of MPP dynamics in mussels (no direct quantitative method in mussels available yet)
Summary

- Definition – Micro – Nano?

- Analytical techniques have to be advanced and harmonized

- Some knowledge about occurrence, but further knowledge is needed about dietary exposure, the fate and toxicity of MPP in seafood and in humans for assessment of the potential health risk of MPP

- Assessment about the factors that cause potential additional or adverse effects is needed
Thank you for your attention

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