U.S. FOOD & DRUG ADMINISTRATION

A Scientific Review of Microplastics in Food and Water

Food Forum Webinar
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Exposure Pathways

- Human Exposure
  - Inhalation
  - Dermal
  - Ingestion
    - Food & Beverages
    - Dust Fallout
    - Other Plastic Products

WHO 2019; Revel et al. 2018

Microplastics Reported in Food & Beverages

Fish	Mollusks	Crustaceans	Bottled Water
Drinking Water	Salt	Honey	Sugar
Beer	Poultry	Nori	Milk
Tea	Soft Drinks	Energy Drinks	

Methodology Considerations

- Lack of standardized definitions or methods
- Lack of appropriate standards
- Lack of standardized reporting metrics
  - Particle concentrations vs mass
- Not all studies used methods that could confirm microplastics
- Lack of quality control
- Challenge for reliable, quantitative data for comparison across studies

Methodology Considerations

"One challenge in this area is that there are different sampling, sample preparation, detection, and characterization methods in use, some of which may not be appropriate or reliable for detecting microplastics."

NASEM, 2020

Microplastics Reported in Food & Water

Fish	**Mollusks**	**Crustaceans**	**Bottled Water**
Drinking Water	Salt	Honey	Sugar
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Tea	Soft Drinks	Energy Drinks	

Seafood

- Reports of microplastics in seafood are predominant
- Reported in fish, mollusks, and crustaceans
- Reliable quantitative data are limited due to method challenges

Polymer Types Reported in Seafood

- Polyamide (PA)
- Polyethylene (PE)
- Polyethylene-co-methyl acrylate (PEMA)
- Polyethylene terephthalate (PET)
- Polyethylene-vinyl acetate (PEVA)
- Polyurethane (PUR)

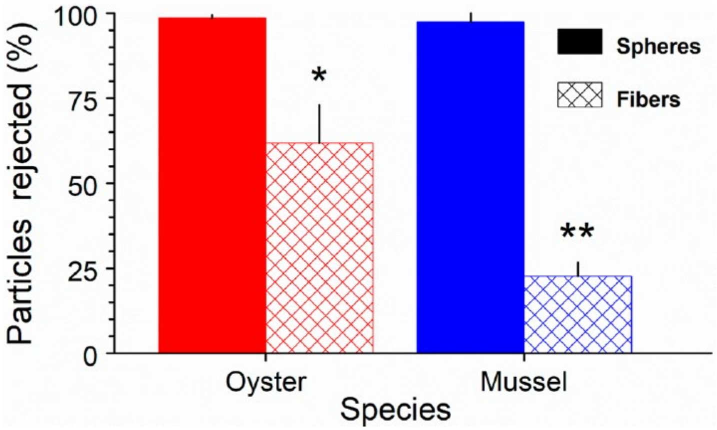
Aquaculture vs Wild-Harvest

- Manila clams and Pacific oysters
- Aquaculture and nearby non-aquaculture
- Microplastics did not significantly differ per site
- Dominance of fibers in shellfish (nylon & polyester)

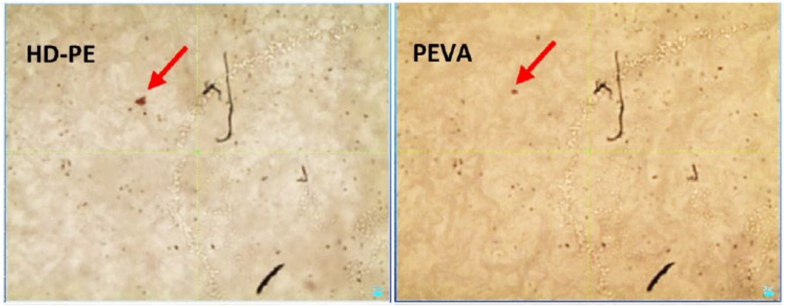
Covernton et al. 2019

Filter-Feeders

Fish Tissue



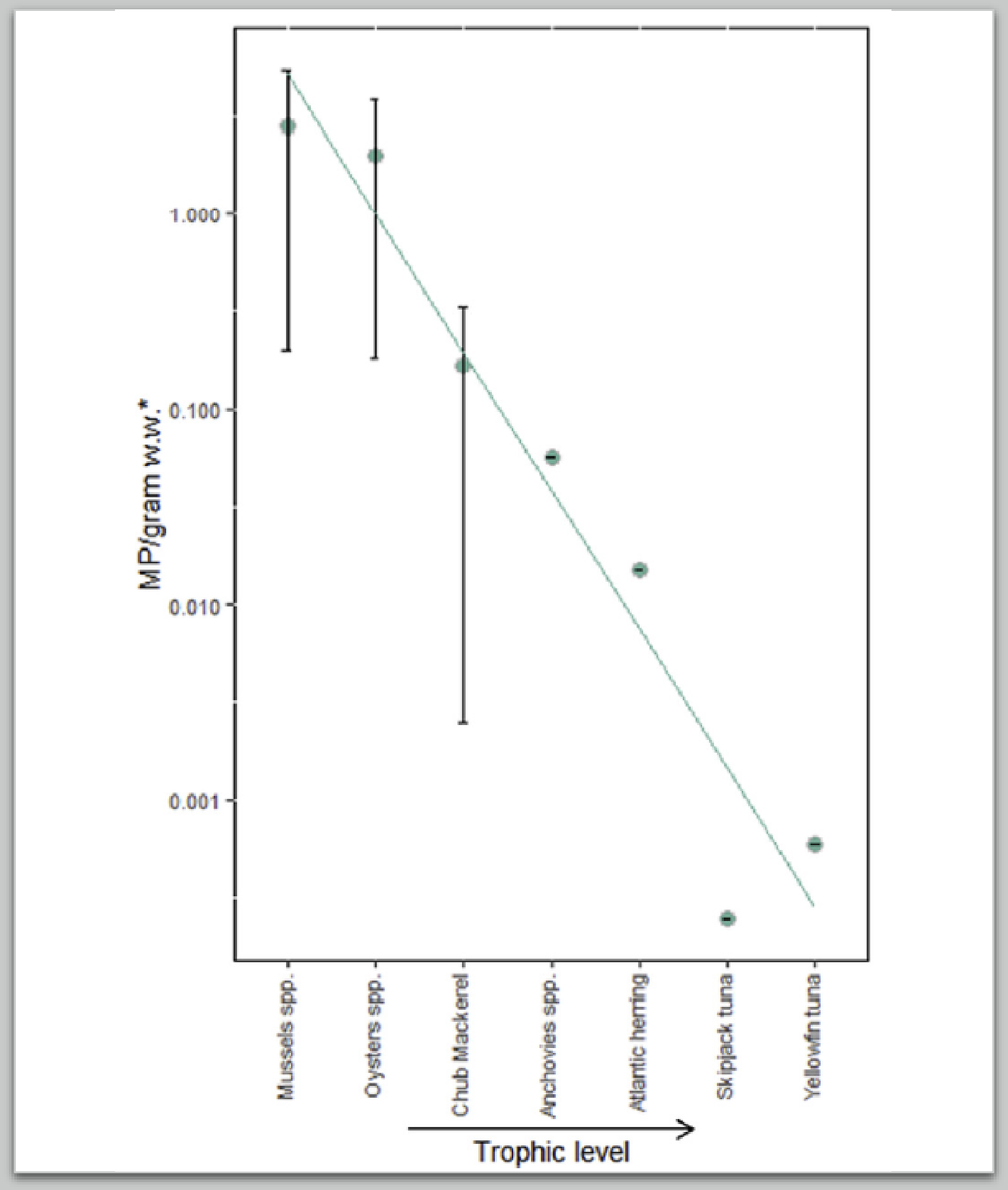
Ward et al., 2019



Zitouni et al., 2020

Bioaccumulation

No evidence of bioaccumulation in higher trophic levels



Walkinshaw et al. 2020

Bottled Water

- Global survey of bottled water
- >100 µm size: ~10.4 MP particles L^{-1}
- 6.5-100 µm size: ~325 MP particles L^{-1}
- Fragments and fibers most common
- PP abundance
- In part associated with packaging and/or bottling process

Mason et al. 2018

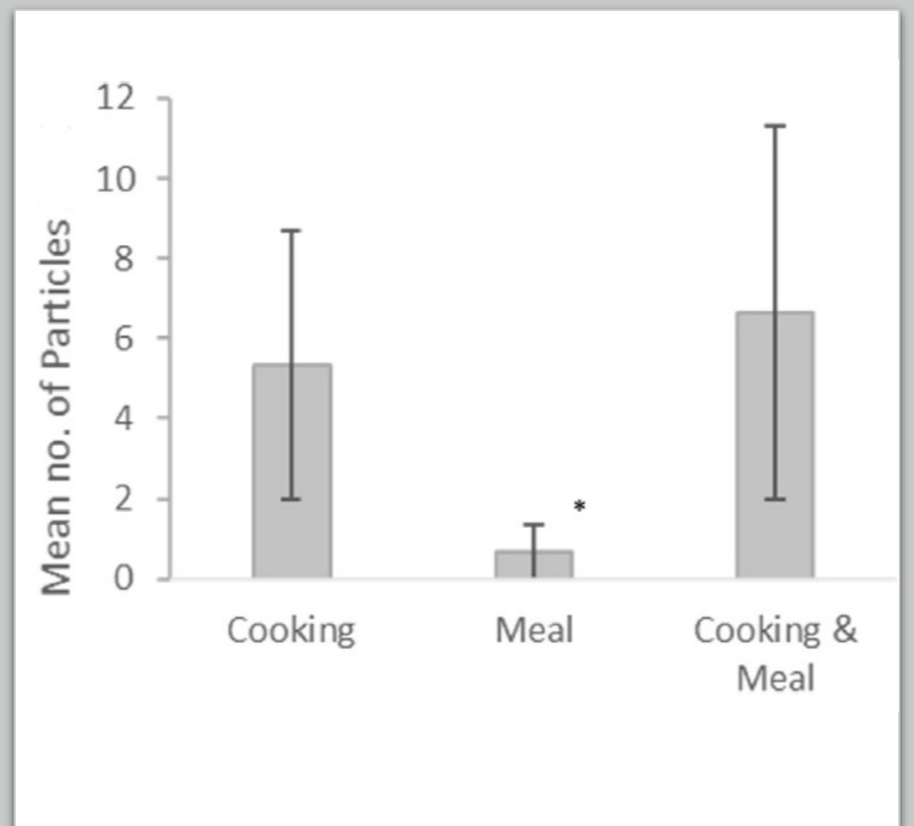
Bottled Water

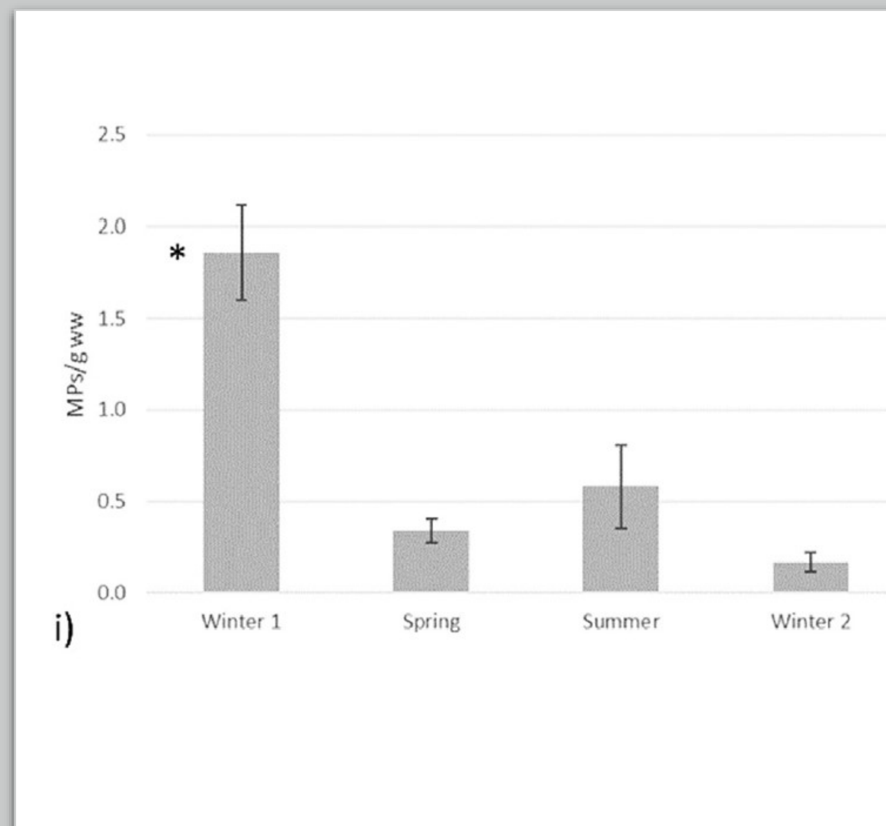
- Microplastics in bottled water
- Single-use < Reusable
- Also detected in glass bottles

WHO 2019

Dust Fallout

- Microplastics in wild mussels vs dust fallout
- Mussels: 123 MP particles/y/capita
- Fallout: 13, 731 MP particles/y/capita
- Exposure context





Catarino et al. 2018

Potential Impact on Human Health

Health **Risk** is a function of:

Hazard and **Exposure**

Occurrence in Foods/Exposure

Toxicity

>150 µm Not absorbed	<150 µm May be absorbed	≤0.3% Limited translocation	→	Gut to circulatory

Microplastics Excretion

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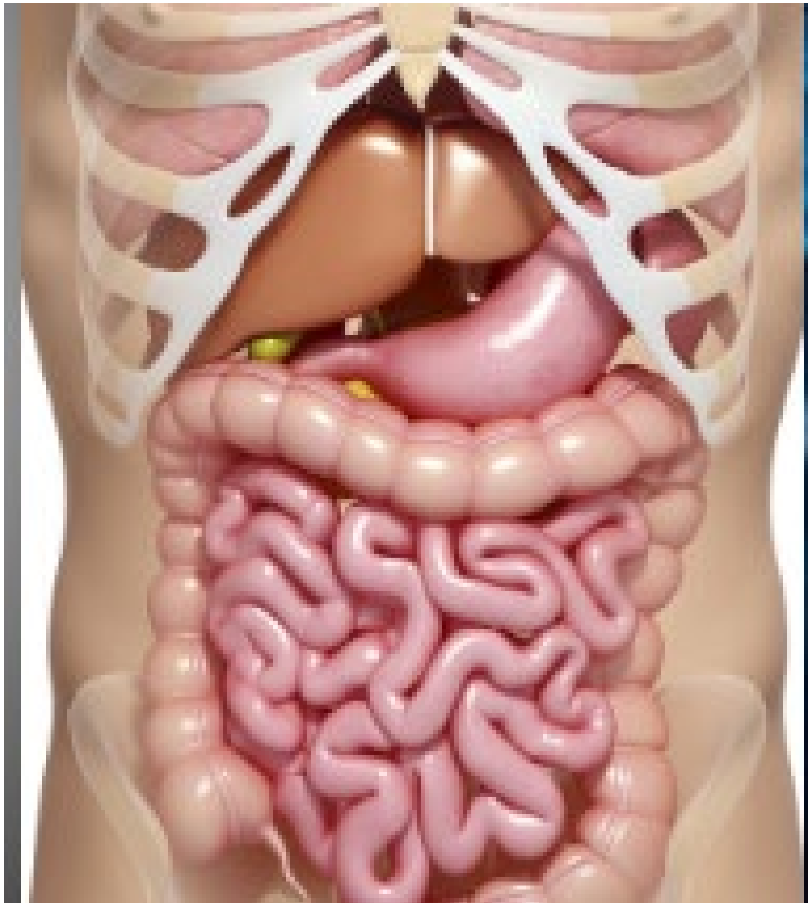
Human stool samples

Positive for microplastics

Median of 20 microplastic particles per 10 g stool

PP and PET, most abundant



Schwabl et al. 2019

Limited Toxicity Studies

SCIENTIFIC REPORTS

OPEN

Tissue accumulation of microplastics in mice and biomarker responses suggest widespread health risks of exposure

Received: 10 October 2016
Accepted: 27 March 2017
Published: 24 April 2017

Yongfeng Deng[1], Yan Zhang[1], Bernardo Lemos[2] & Hongqiang Ren[1]

Energy and lipid metabolism
Oxidative stress
Neurotoxic

Deng et al. 2017

Archives of Toxicology (2019) 93:1817–1833
https://doi.org/10.1007/s00204-019-02478-7

REGULATORY TOXICOLOGY

Uptake and effects of orally ingested polystyrene microplastic particles in vitro and in vivo

Valerie Stock[1] · Linda Böhmert[1] · Elisa Lisicki[1] · Rafael Block[1] · Julia Cara-Carmona[1] · Laura Kim Pack[1] · Regina Selb[1] · Dajana Lichtenstein[1] · Linn Voss[1] · Colin J. Henderson[2] · Elke Zabinsky[3] · Holger Sieg[1] · Albert Braeuning[1] · Alfonso Lampen[1]

Minor uptake observed
Absence of histological lesions
Absence of inflammatory response

Stock et al. 2019

Conclusions

Microplastics have been reported in a range of foods

There are limitations in drawing quantitative conclusions due to methodology challenges

Polymers in seafood exhibited the greatest variability, compared to other foods

Polymer types in bottled water may have been associated with processing and packaging

Microplastics from dust fallout during meal preparation have been reported

There is a lack of evidence clearly supporting that microplastics impact human health

Knowledge Gaps

General

- Lack of standard definitions of micro- and nanoplastics
- Lack of standardized and fit-for-purpose metrics for data reporting

Knowledge Gaps

Methods

Lack of appropriate:
- standards and reference materials
- standardized sample collection and preparation techniques
- standardized detection methods

Method exploration to validation

Qualitative and quantitative measurements

Real world, environmentally relevant mixtures

Microplastics and especially for nanoplastics

Knowledge Gaps

Occurrence in Foods

Lack of:

- accurate/quantitative data on micro- and nanoplastics exposure via food
- exposure estimates on wide range of foods for each plastic type
- studies examining plastic mulching as a significant source of microplastics in terrestrial environments

Knowledge Gaps
Toxicology and Pharmacology

Lack of understanding on fate and transport	Uptake in and effects on the gut Distribution/metabolism
Lack of understanding of dosimetry	Mass- versus particles-based toxicity
Lack of understanding of micro- and nanoplastics toxicity to humans	Consideration of complex plastics particle sizes, shapes, and types

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