Behavior of silver nanoparticles and ions in food simulants and low fat cow milk under migration conditions

Research on the potential migration of nanoparticles (NPs) from nano-based food contact materials (FCMs) has often reached inconsistency in previous studies. Conventional food simulants and traditional migration tests, which are established for small molecules, have been used for studying the potential migration of NPs from nano-based FCMs. The suitability of conventional food simulants and migration tests was investigated by studying the behavior of 40nm polyethylene glycol (PEG) coated AgNPs and silver ions in food simulants (10% ethanol, 20% ethanol, 50% ethanol, 3% acetic acid, olive oil) under migration conditions. Particle mass and number concentrations, ionic concentration and particle size distributions were determined by single particle inductively coupled plasma-mass spectrometry (spICP-MS) before and after incubation for 4h or 10 days at 40°C. In agreement with similar studies, 50% ethanol preserved the AgNPs, while acetic acid induced dissolution of AgNPs. Dissolution of the PEG-AgNPs obeyed pseudo-first-order reaction kinetics. PEG-AgNPs showed similar behavior in low fat cow milk during storage at 4°C for 5 days as in the corresponding food simulant, 50% ethanol. Addition of sodium chloride to ultrapure water led to enhanced dissolution. The potential reduction of silver ions to NPs in food simulants, low fat milk and in alkaline conditions in the presence of reducing agents was studied. Based on the obtained results, it is unlikely that AgNPs are formed from Ag ions at the low concentration which are typically observed for the migration of Ag from polymeric FCMs.
This study investigated Chinese noodles for the presence of aluminium-containing nanoparticles by using inductively coupled plasma mass spectrometry in single particle mode (spICP-MS) after enzymatic digestion by α-amylase. The aluminium concentrations in the noodle samples, determined by conventional ICP-MS without or with the use of hydrofluoric acid for digestion, were $5.4 \pm 1.9 \mu g/g$ and $10.1 \pm 2.2 \mu g/g$ ($N = 21$), respectively. Aluminium-containing nanoparticles were detected by spICP-MS in all 21 samples. Depending on the assumed particle composition, Al$_2$O$_3$ or Al$_2$O$_3$$\cdot$2SiO$_2$$\cdot$2H$_2$O, the median particle diameters were either below or above 100 nm, respectively. The minimum detectable particle diameter by spICP-MS was between 54 and 83 nm. The mass recovery of aluminium in the form of nanoparticles was between 5% and 18%. The presented work reports for the first time the detection of Al-containing particles in food by spICP-MS.
Detection of nanoplastics in food by asymmetric flow field-flow fractionation coupled to multi-angle light scattering: possibilities, challenges and analytical limitations

We tested the suitability of asymmetric flow field-flow fractionation (AF4) coupled to multi-angle light scattering (MALS) for detection of nanoplastics in fish. A homogenized fish sample was spiked with 100 nm polystyrene nanoparticles (PSNPs) (1.3 mg/g fish). Two sample preparation strategies were tested: acid digestion and enzymatic digestion with proteinase K. Both procedures were found suitable for degradation of the organic matrix. However, acid digestion resulted in large PSNPs aggregates/agglomerates (> 1 μm). The presence of large particulates was not observed after enzymatic digestion, and consequently it was chosen as a sample preparation method. The results demonstrated that it was possible to use AF4 for separating the PSNPs from the digested fish and to determine their size by MALS. The PSNPs could be easily detected by following their light scattering (LS) signal with a limit of detection of 52 μg/g fish. The AF4-MALS method could also be exploited for another type of nanoplastics in solution, namely polyethylene (PE). However, it was not possible to detect the PE particles in fish, due to the presence of an elevated LS background. Our results demonstrate that
an analytical method developed for a certain type of nanoplastics may not be directly applicable to other types of nanoplastics and may require further adjustment. This work describes for the first time the detection of nanoplastics in a food matrix by AF4-MALS. Despite the current limitations, this is a promising methodology for detecting nanoplastics in food and in experimental studies (e.g., toxicity tests, uptake studies). [Figure not available: see fulltext.]

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Authors: Correia, M. (Intern), Löschner, K. (Intern)
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Web of Science (2015): Indexed yes
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ISI indexed (2013): ISI indexed yes
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BFI (2009): BFI-level 1
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.981 SNIP 1.048
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Translocation of silver nanoparticles in the ex vivo human placenta perfusion model characterized by single particle ICP-MS

With the extensive use of silver nanoparticles (AgNPs) in various consumer products their potential toxicity is of great concern especially for highly sensitive population groups such as pregnant women and the developing fetus. To understand if AgNPs are taken up and cross the human placenta, we studied their translocation and accumulation in the human ex vivo placenta perfusion model by single particle ICP-MS (spICP-MS). The impact of different surface modifications on placental transfer was assessed by AgNPs with two different modifications: polyethylene glycol (AgPEG NPs) and sodium carboxylate (AgCOONa NPs). AgNPs and ionic Ag were detected in the fetal circulation in low but not negligible amounts. Slightly higher Ag translocation across the placental barrier for perfusion with AgPEG NPs and higher AgNPs accumulation in placental tissue for perfusion with AgCOONa NPs were observed. Since these AgNPs are soluble in water, we tried to distinguish between the translocation of dissolved and particulate Ag. Perfusion with AgNO3 revealed the formation of Ag containing NPs in both circulations over time, of which the amount and their size in the fetal circulation was comparable to those from perfusion experiments with both AgNP types. Although we were not able to clarify whether intact AgNPs and/or Ag precipitates from dissolved Ag cross the placental barrier, our study highlights that uptake of Ag ions and/or dissolution of AgNPs in the tissue followed by re-precipitation in the fetal circulation needs to be considered as an important pathway in studies of AgNP translocation across biological barriers.

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Scopus rating (2016): CiteScore 7.46 SJR 2.789 SNIP 1.441
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.77 SNIP 1.542 CiteScore 7.97
A 3D human co-culture microtissue model for nanoparticle effect and uptake studies at the placental barrier

General information
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Organisations: National Food Institute, Research Group for Nano-Bio Science, Swiss Federal Laboratories for Materials Testing and Research, Swiss Federal Laboratories for Materials Science and Technology (Empa), University College Dublin, Karolinska Institutet, Cantonal Hospital St. Gallen
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Publication: Research - peer-review » Conference abstract in proceedings – Annual report year: 2017

Simultaneous on-line detection of SiO2, TiO2 and Al2O3 particles in toothpaste by asymmetric flow field-flow fractionation hyphenated to inductively coupled plasma mass spectrometry

General information
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Organisations: National Food Institute, Research Group for Nano-Bio Science
Authors: Correia, M. (Intern), Löschner, K. (Intern)
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Solutions to practical challenges in developing dispersion procedures for nanoparticle characterization and toxicological testing

General information
State: Published
Organisations: National Food Institute, Research Group for Nano-Bio Science
Authors: Löschner, K. (Intern), Correia, M. (Intern)
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A 3D co-culture microtissue model of the human placenta for nanotoxicity assessment
There is increasing evidence that certain nanoparticles (NPs) can overcome the placental barrier, raising concerns on potential adverse effects on the growing fetus. But even in the absence of placental transfer, NPs may pose a risk to proper fetal development if they interfere with the viability and functionality of the placental tissue. The effects of NPs on the human placenta are not well studied or understood, and predictive in vitro placenta models to achieve mechanistic insights on NP-placenta interactions are essentially lacking. Using the scaffold-free hanging drop technology, we developed a well-organized and highly reproducible 3D co-culture microtissue (MT) model consisting of a core of placental fibroblasts surrounded by a trophoblast cell layer, which resembles the structure of the in vivo placental tissue. We could show that secretion levels of human chorionic gonadotropin (hCG) were significantly higher in 3D than in 2D cell cultures, which indicates an enhanced differentiation of trophoblasts grown on 3D MTs. NP toxicity assessment revealed that cadmium telluride (CdTe) and copper oxide (CuO) NPs but not titanium dioxide (TiO2) NPs decreased MT viability and reduced the release of hCG. NP acute toxicity was significantly reduced in 3D co-culture MTs compared to 2D monocultures. Taken together, 3D placental MTs provide a new and promising model for the fast generation of tissue-relevant acute NP toxicity data, which are indispensable for the safe development of NPs for industrial, commercial and medical applications.

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Journal: Nanoscale
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Genotoxicity of copper oxide nanoparticles with different surface chemistry on rat bone marrow mesenchymal stem cells

The surface chemistry of nanoparticles (NPs) is one of the critical factors determining their cellular responses. In this study, the cytotoxicity and genotoxicity of copper oxide (CuO) NPs with a similar size but different surface chemistry to rat bone marrow mesenchymal stem cells (MSCs) were investigated. The morphology, size and surface charge of four types of CuO NPs, i.e., CuO-core, CuO-COOH, CuO-NH2 and CuO-PEG NPs, were characterized by TEM, dynamic light scattering (DLS) and zeta-potential measurement, respectively. All of the four CuO NPs had a negative surface charge around -10 mV and showed a similar tendency to form agglomerates with a size of ∼200 nm in cell culture environment. The cytotoxicity of CuO NPs to MSCs at various concentrations and incubation periods were firstly evaluated. The CuO NPs showed dose-dependent and time-dependent toxicity to MSCs, and their surface chemistry had influence on the toxicity to some extent too. The intracellular reactive oxygen species (ROS) level of MSCs was then quantified. Finally, the genotoxicity of the CuO NPs was studied by comet assay. The results suggest that the genotoxicity of CuO NPs was mainly dependent on NPs concentration, and was only slightly influenced by their surface chemistry. The osteogenic and adipogenic differentiation abilities of the MSCs exposed to different CuO NPs were studied by Alizarin Res S and Oil Red O staining. The preliminary results showed that the exposure to 10 μg/mL CuO NPs will not lead to significant impact on the differentiation potential of the MSCs.
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.334 SNIP 0.477 CiteScore 1.23
BFI (2014): BFI-level 1
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.339 SNIP 0.538 CiteScore 1.26
ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): SJR 0.422 SNIP 0.495 CiteScore 1.21
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.55 SNIP 0.69 CiteScore 1.47
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.574 SNIP 0.52
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.674 SNIP 0.58
Web of Science (2009): Indexed yes
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Scopus rating (2006): SJR 1.007 SNIP 0.738
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Scopus rating (2004): SJR 1.007 SNIP 0.665
Web of Science (2004): Indexed yes
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Scopus rating (2002): SJR 1.161 SNIP 1.075
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Toxicity of Pristine and Aged Coated Copper Oxide Engineered Nanomaterials (CuO ENMs) to the Earthworm E. fetida

Detection and characterization of aluminium-containing nanoparticles in a complex food matrix

Simultaneous On-Line Detection of Si, Ti and Al-Containing Particles in Toothpaste by Asymmetric Flow Field-Flow Fractionation Coupled with ICP–QQQ–MS
Development of dispersion procedures for surface-functionalized CuO nanoparticles to use in large-scale toxicity studies

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Dispersion and characterization of surface-functionalized CuO nanoparticles for toxicity testing.

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Organisations: National Food Institute, Research Group for Nano-Bio Science
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Projects:
Analytical methodology for chemical screening and analyses in food surveillance
National Food Institute
Research Group for Nano-Bio Science
Period: 01/01/2015 → 31/12/2018
Number of participants: 2
Acronym: ASTERIX
Project participant:
Löschner, Katrin (Intern)
Correia, Manuel (Intern)
Project

Development of an integrated approach based on validated and standardized methods to support the implementation of the EC recommendation for a definition of nanomaterial
Nanotechnology is a key enabling technology. Still existing uncertainties concerning EHS need to be addressed to explore the full potential of this new technology. One challenge consists in the development of methods that reliably identify, characterize and quantify nanomaterials (NM) both as substance and in various products and matrices. The European Commission has recently recommended a definition of NM as reference to determine whether an unknown material can be considered as 'nanomaterial' (2011/696/EU). The proposed NanoDefine project will explicitly address this question. A consortium of European top RTD performers, metrology institutes and nanomaterials and instrument manufacturers has been established to mobilize the critical mass of expertise required to support the implementation of the definition. Based
on a comprehensive evaluation of existing methodologies and a rigorous intra-lab and inter-lab comparison, validated measurement methods and instruments will be developed that are robust, readily implementable, cost-effective and capable to reliably measure the size of particles in the range of 1–100 nm, with different shapes, coatings and for the widest possible range of materials, in various complex media and products. Case studies will assess their applicability for various sectors, including food/feed, cosmetics etc. One major outcome of the project will be the establishment of an integrated tiered approach including validated rapid screening methods (tier 1) and validated in depth methods (tier 2), with a user manual to guide end-users, such as manufacturers, regulatory bodies and contract laboratories, to implement the developed methodology. NanoDefine will be strongly linked to main standardization bodies, such as CEN, ISO and OECD, by actively participating in TCs and WGs, and by proposing specific ISO/CEN work items, to integrate the developed and validated methodology into the current standardization work.

WP2 leadership
National Food Institute
Division of Food Chemistry
Research Group for Nano-Bio Science
RIKILT
Centrum voor Onderzoek in Diergeneeskunde en Agrochemie
Swiss Federal Institute of Aquatic Science and Technology
European Commission - Joint Research Center
University of Vienna
Period: 01/11/2013 → 30/10/2017
Number of participants: 2
Acronym: NanoDefine
Project participant:
Löschner, Katrin (Intern)
Correia, Manuel (Intern)

Relations
Activities:
Sample preparation is critical both for substances and products
Sampling and sample preparation is critical
NANODEFINE Exploitation Strategy Seminar
2nd NanoDefine “NSC Synergy Workshop”

Biological Foundation for the Safety Classification of Engineered Nanomaterials (ENM): Systems Biology Approaches to Understand Interactions of ENM with Living Organisms and the Environment
Partner in WP 3
National Food Institute
Division of Food Chemistry
Research Group for Nano-Bio Science
Period: 01/04/2013 → 31/03/2017
Number of participants: 2
Acronym: NanoSolutions
Project participant:
Löschner, Katrin (Intern)
Correia, Manuel (Intern)

Relations
Activities:
Solutions to Practical Challenges in Developing Procedures for Nanoparticle Characterization and Toxicological Testing
NANOSOLUTIONS - NanoMILE Workshop
Activities:

Detection and characterization of aluminium-containing nanoparticles in a complex food matrix
Period: 5 Nov 2015
Manuel Correia (Speaker)
National Food Institute
Research Group for Nano-Bio Science

Description
1st European workshop: Analysis of nanoparticles in food, cosmetics and consumer products

Related event
7th International Symposium on Recent Advances in Food Analysis
03/11/2015 → 06/11/2015
Prague, Czech Republic
Activity: Talks and presentations › Conference presentations

NanoDefine (EU FP7 Project) Workshop - Internal training for PhD students and PostDocs
Period: 24 Apr 2015
Manuel Correia (Speaker)
National Food Institute
Research Group for Nano-Bio Science

Description
Oral presentation/Lecture: FFF-MALS-ICPMS method for detection of SiO2 NPs in complex matrices

Related event
NanoDefine (EU FP7 Project) Workshop - Internal training for PhD students and PostDocs
24/04/2015 → 24/04/2015
Vienna, Austria
Activity: Other

Development of dispersion procedures for surface-functionalized CuO nanoparticles to use in large-scale toxicity studies.
Period: 8 Oct 2014
Manuel Correia (Speaker)
National Food Institute
Research Group for Nano-Bio Science

Related event
NanoSafety Forum for Young Scientists, Syracuse, Italy
08/10/2014 → 09/10/2014
Syracuse, Italy
Activity: Talks and presentations › Conference presentations

Dispersion and characterization of surface-functionalized CuO nanoparticles for toxicity testing.
Period: 23 Apr 2014 → 26 Apr 2014
Manuel Correia (Speaker)
National Food Institute
Research Group for Nano-Bio Science

Description
Poster presentation

Related event
7th International Nanotoxicology Congress, Antalya, Turkey
23/04/2014 → 26/04/2014
Antalya, Turkey
Activity: Talks and presentations › Conference presentations

Prizes:

Best presentation award at the symposium NanoSafety Forum for Young Scientists
Manuel Correia (Recipient)
National Food Institute, Research Group for Nano-Bio Science

Details
Awarded date: 8 Oct 2014
Granting Organisations: NanoSafety Forum for Young Scientists 2014
Prize: Prizes, scholarships, distinctions