Toxicological safety assessment of nanocellulose – why and how?

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1. Introduction

• SUNPAP project: From research to lab scale and to end products

• One of the main targets of the project is risk assessment

• SUNPAP Module 4 is devoted to these aspects

As there were no explicit international guidelines for risk assessment of nanocellulose, it was necessary to outline a risk assessment methodology adapted to the needs of this project.
2. What makes nanoparticles and nanomaterials special?

- Unique properties which make them interesting for commercial purposes, but also can introduce new hazards
  - Nanoparticles can be distributed from the site of entry to elsewhere in the body and, to some degree, cross physiological barriers
  - After exposure, many inorganic nanoparticles have been detected e.g. in brains, inner organs and embryos
  - Many nanomaterials catalyse the formation of reactive oxygen species
- There are a lot of studies on the toxic effects of different inorganic nanomaterials
3. The special case of nanocellulose – why to worry?

Nanocellulose has properties that may be associated with health risks

- Needle-like shape
- Biopersistence in the body

Somewhat similar properties to inorganic fibres which are known to have health risks

However, in contrast to rigid mineral fibres, nanocellulose has a flexible structure, which may eliminate the safety concerns

Source: INP Grenoble/CTP, SUNPAP Newsletter 2 in http://sunpap.vtt.fi
4. Risk assessment methodology

• By 2010, no widely accepted risk assessment methodology existed for nanomaterials
  • Method development has been challenging
  • Challenges also include exposure assessment
• Quite recently international organisations have taken the first steps to define an appropriate methodology e.g.
  • ISO/TR 13121 Technical Report 2011: Nanomaterial risk evaluation
  • EFSA 2011 Guidance on the risk assessment of the application of nanoscience and nanotechnologies in the food and feed chain
5. The SUNPAP approach for outlining risk assessment methodology

- **Review** of the state-of-the-art of risk assessment reports
- **Definition of a risk assessment methodology** adapted to the needs of this project
- Goal is to use this in communicating risk assessment of nanocellulose to
  - other SUNPAP partners
  - the general public interested in the safety and applications of nanomaterials

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\text{Risk} = \text{exposure} \times \text{hazard}
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6.1. Hazard assessment methodology for nanocellulose proposed in the SUNPAP project

1. Screening the bioactivities of different NCs/FNCs
   - In vitro tests
     - To detect any cellular damage and to assess possible systemic effects
   - A nematode model
     - To investigate potential systemic effects and neurotoxicity
   - Pharyngeal aspiration toxicity study with mice
     - To investigate the pulmonary effects of nanocellulose

2. Inhalatory toxicity
   - Animal tests
6.2. Experiences of the use of the SUNPAP hazard assessment scheme

• Individual tests of the screening phase have been tested with a commercial nanocellulose (JRS-Arbocell) as a model

  • The suggested methodology appears suitable, and the individual tests can be adapted to meet the special challenges associated with the test material (microbial contamination, proper dispersion of the sample)

• So far, no indication of toxicity related to JRS-Arbocell in test where positive controls have produced expected results.

• The results are in agreement with the recently published studies on the toxicity of different micro- and nanocelluloses which do not indicate any concerns on micro- and nanocelluloses: O’Connor et.al., 2009; Rojaset.al., 2009; Kovacs et.al. 2010; Vartiainen et.al. 2011; Pitkänen et.al., 2010
6.3 Risk assessment methodology

• Occupational exposure assessment
  • Possible exposure routes: inhalation, dermal and ingestion
  • Estimation of exposure level (used amount, dustiness)
  • Time of exposure: duration and frequency of work
  • Number of workers

• Risk assessment
  • Qualitative risk assessment and management by using Control banding approach for nanomaterials will conducted
Summary

- Nano-sized cellulose, have great potential; however, their safety aspects have to be properly addressed

- The methodology for the safety assessment of nanoparticles and nanomaterials is under development, and a single approach for all types of particles and materials may not be feasible

- The test battery designed for the SUNPAP project, appears to be suitable for the testing of nanocellulose

- The testing of actual project materials is, accordingly, in progress following the SUNPAP test scheme
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