Toxicological safety assessment of nanocellulose – why and how?

Juulia Rouhiainen, Pöyry

SUNPAP Workshop 5.10.2011

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

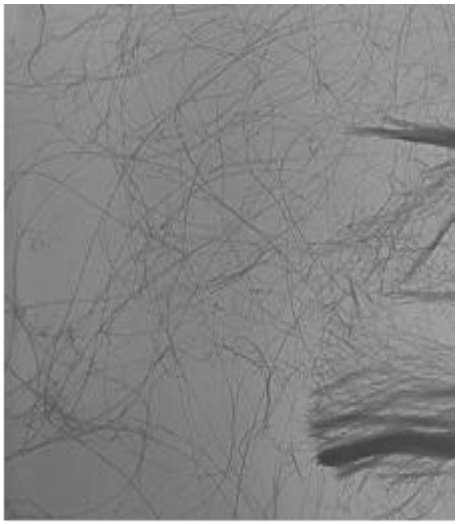
3. The special case of nanocellulose – why to worry?

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

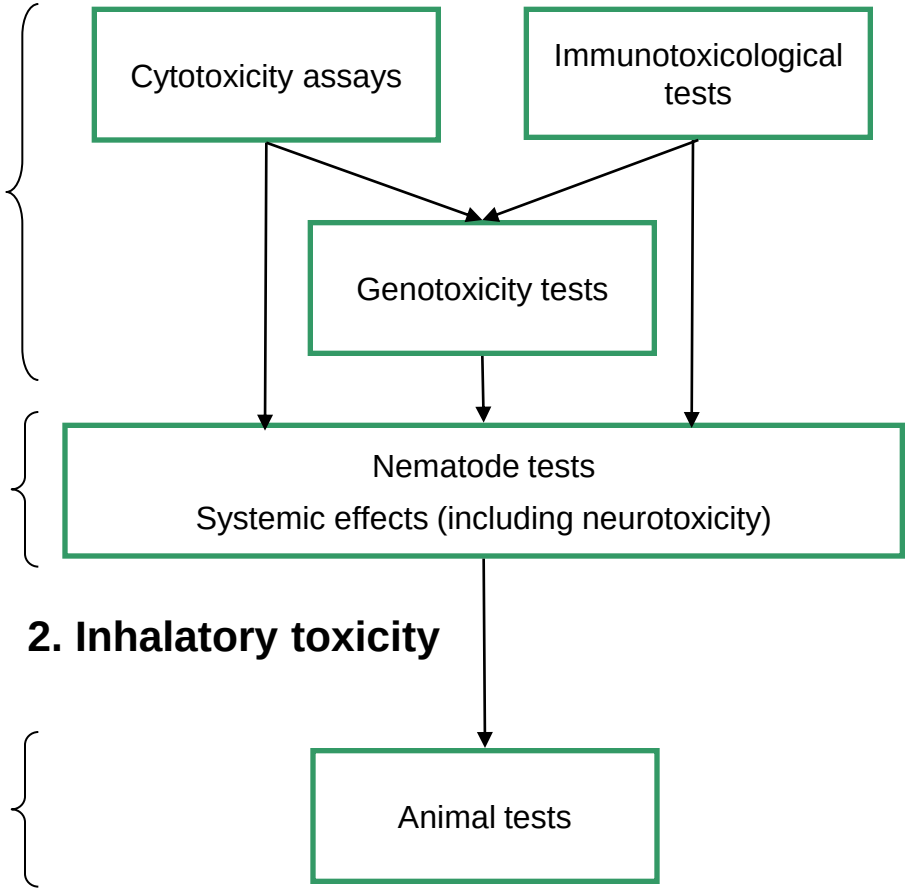
- **Review** of the state-of-the-art of risk assessment reports
- **Definition of a risk assessment methodology** adapted to the needs of this project
- Goal is to use this in **communicating risk assessment of nanocellulose** to
  - other SUNPAP partners
  - the general public interested in the safety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

Risk = exposure x hazard

6.1. Hazard assessment methodology for nanocellulose proposed in the SUNPAP project

- *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

1.Screening the bioactivities of different NCs/FNCs



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

The Module 4 partners acknowledged

- BioSafe Special Laboratory Services Ltd (BIOSS)
  - Atte von Wright
  - Ulla Honkalampi
- Finnish Institute of Occupational Health (FIOH)
  - Elina Rydman
  - Marjut Ilves
  - Lea Pylkkänen
  - Hannu Norppa
  - Kati Hannukainen
  - Virpi Väänänen
- Pöyry Management Consulting Oy (POYRY)
  - Juulia Rouhiainen
- Technical Research Centre of Finland (VTT)
  - Irina Tsitko

Acknowledgment

- The research leading to these results received funding from the European Community's Seventh Framework Programme under Grant Agreement No 228802.