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DO NANO-BIOMATERIALS DESIGNED FOR DRUG DELIVERY AFFECT SOIL MICROFLORA?

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Introduction & objectives

A biomaterial (BM) is defined as any material that has been designed to interact with biological systems for a medical purpose. In the EU-project BIORIMA we investigated the ecotoxicity with a focus on soil microflora. NBMs (nanobiomaterials) excreted by treated patients can via sewage get into wastewater treatment plants and via sewage sludge, applied as fertilizer, to soil and soil microflora. Several materials designed for targeted drug delivery were tested on microbial activity (nitrification and respiration). Thereby, two test systems on repiration were considered. One of them, the MicroResp™ test system for measuring microbial respiration, could be an alternative test system to conventional test devices. So far, it has not been used to study effects on soil microbial processes in a regulatory context, but EFSA (2017) recommends that its capability in that respect is determined.

Approach

1. Test material
   - *SLN_Nutra_10.x.y_Sol*
     Composition: water-based colloidal suspension of solid-lipid nanopararticles with a mean hydrodynamic diameter of 340 nm.
     Application: food supplements; dispersion of hydrophobic drugs (e.g. like Q10, curcumin, melatonin,) enhancing their adsorption and bioavailability.
   - *AuNPs_3.x.y_Sol*
     Composition: aqueous suspension of Au NPs (0.5 % Au) with a mean hydrodynamic diameter of 40 nm.
     Application: antimicrobial, x-ray contrast agent, photodynamic therapy.
2. Methods
   - Potential ammonium oxidation PAO (ISO 15685, 2012)
   - Basal respiration and substrate induced respiration (SIR) using glucose
     – MicroResp™: incubation in 96-well plates; measurement of respiration activity at test start and test end.
     – Sapromat: glucose; online measurement requiring soil amounts of 100 g dry matter per replicate
     – Incubation at 20 °C for 28 days
3. Soil
   - Loamy sand; Corg: 1.1 %, pH ($CaCl_2$): 5.0

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Conclusion

1. Depending on the microbial activity, stimulation and/or inhibition can be detected for the same NBM in the different test systems. To **understand the changes** in the soil microbial community, **both microbial activities (respiration, nitrification) have to be considered**.
2. There are **obvious differences in the respiration results between the two test systems** (e.g. Au NP - SIR) and these need to be studied in future research.
3. An **ecotoxicological effect of NBM** cannot be excluded – however presumably only **at high concentrations** and thus does not have any environmental relevance (Au NP, 100 mg/kg – PAO).
4. For dispersed materials, the additional **investigation of the pure dispersant** is required (stimulation in resiparation (e.g. SLN_Nutra).
5. Due to **biological variability** the investigation of **several concentrations and several time points** are necessary for an assessment of NBM on soil microflora.

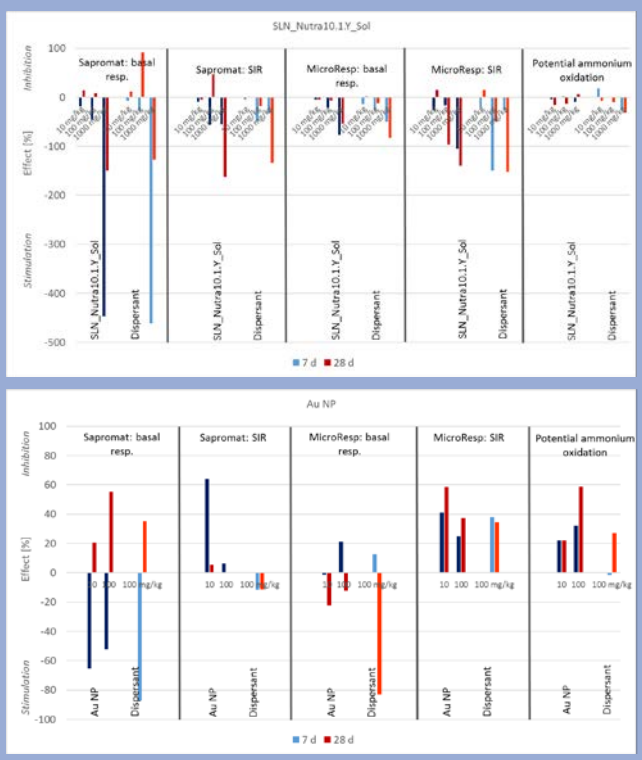

Figure 1: Effect of two nanobiomaterials on the soil microflora

Session: The environment as a reactor determining fate and toxicity of nanomaterials (P)
Poster, Exhibition hall, ID WE138
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Do nano-biomaterials designed for drug delivery affects soil microflora?

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A biomaterial (BM) is defined as any material that has been designed to interact with biological systems for a medical purpose. Conventional BM are well regulated, however existing guidelines need to be extended to address specific nano related concerns. In the EU-project BIORIMA we investigated the ecotoxicity with a focus on soil microflora. NBMs (nanobiomaterials) excreted by treated patients can via sewage get into wastewater treatment plants and via sewage sludge applied as fertilizer to soil and soil microflora. Several materials designed for targeted drug delivery were tested on the potential ammonium oxidation activity (first step of nitrification) which proved to be a very sensitive test system for conventional nanomaterials. Additionally, the effect on basal and substrate induced respiration with two test systems was investigated. Due to the high number of various NMs a reduced testing effort is essential. The MicroResp® test system for measuring microbial respiration, could be an alternative test system to conventional test devices. So far, it has not been used to study effects on soil microbial processes in a regulatory context, but EFSA (2017) recommends that its capacity in that respect is determined. We compared the results of a conventional approach (Sapromat; online measurement of microbial activity requiring soil amounts of at least 100 g soil dry matter per replicate) with the miniaturized approach (only two measurement times: start, end; about 300 mg/soil per replicate).

Conclusions: 1. Due to biological variability the investigation of several concentrations and several time points are necessary for an assessment of NBM on soil microflora. 2. For dispersed materials, the additional investigation of the pure dispersant is required. 3. An ecotoxicological effect of NBM cannot be excluded – however presumably only at high concentrations and thus does not have any environmental relevance; 4. To understand the changes in the soil microbial community, both microbial activities (respiration, nitrification) have to be considered. Depending on the activity, stimulation and inhibition can be detected for the same NBM in the different test systems. 5. There are obvious differences in the respiration results between the two test systems and these need to be studied in future research.

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Key words: Nanobiomaterials, hazard, soil microflora, ecotoxicity