

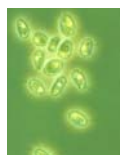
## Benefit of ecotoxicological tests for the characterization of composts



**Fraunhofer**  
Institut  
Molekularbiologie und  
Angewandte Oekologie

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## Input material for compost: A mixture of desired and undesired ingredients



- ✦ Plasticizer (plastic bags)
- ✦ Pesticides (fruit shells)
- ✦ PAHs (ubiquitous, e.g. branches of trees growing near highways)
- ✦ Heavy metals (ubiquitous)
- ✦ Antibiotics (faeces, disposal of pharmaceuticals)

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## Analyses of compost

☛ **Application of contaminated compost has to be avoided**  
→ **Conduction of chemical analysis**



☛ **Assessment of contaminated/remediated soils and wastes:**  
**ecotoxicological analysis as supplement to chemical analysis;**  
**methods developed for the assessment of chemicals are adapted**  
**and applied**



| Chemical analysis  | Ecotoxicological analysis                                 |
|--|---|
| Limited selection of substances (usually no metabolites) | All toxic contaminants (parent compounds and metabolites) |
| Usually total content                                    | Available portion   |

## Ecotoxicological tests for soils and wastes

**Much experience concerning ecotox tests for soils and wastes**  
**(round robin tests; standardized) → Suitable for composts??**

### Compost:

- ☛ **high nutrient content**
- ☛ **content of organic matter**
- ☛ **pH**
- ☛ **salinity**

## Structure of the presentation

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1. Experiences with ecotox tests applied to soils and wastes  
→ advantages of the tests
2. Experiences with ecotox tests applied to composts



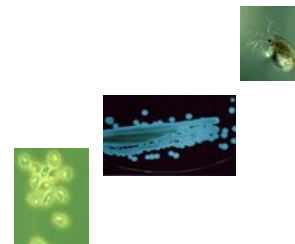
- ➔ "Answer" concerning the suitability of ecotox tests for composts

## Test systems

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- 🐼 Information on **leachable contaminants**  
(→ contamination of groundwater)

Aqueous soil eluates + **aquatic organisms**  
(e.g. daphnids, algae, luminescent bacteria)  
→ behaviour (e.g. immobilization, growth, luminescence) of organisms is determined



- 🐼 Information about the **habitat function** of the material

Soil or waste + **terrestrial organisms**  
(e.g. earthworms, collembola, plants, microorganisms)  
→ behaviour (reproduction, growth, activity) of organisms is determined



Is there an added value by ecotoxicological tests?



Performance of ecotox tests increase costs  
 → only justified if added value is achieved

*Example: contaminated soil, excavated during a construction process*

| Aquatic test organisms | Soil 1 | Soil 2 | Soil 3 | Soil 4 |                              |
|------------------------|--------|--------|--------|--------|------------------------------|
| Luminescent bacteria   |        |        |        |        | results indicate no toxicity |
| Algae                  |        |        |        |        |                              |



Is there an added value by ecotoxicological tests?




*Example: contaminated soil, excavated during a construction process*

| Terrestrial test              | Soil 1 | Soil 2 | Soil 3 | Soil 4 |                                |
|-------------------------------|--------|--------|--------|--------|--------------------------------|
| Microorganisms: respiration   |        |        |        |        | results indicate no limitation |
| Microorganisms: nitrification |        |        |        |        |                                |
| Earthworms: reproduction      |        |        |        |        |                                |
| Collembola: reproduction      |        |        |        |        |                                |
| Plants: biomass               |        |        |        |        |                                |



### Is there an added value by ecotoxicological tests?



Performance of ecotox tests increase costs

→ o

Exam

|               |   |
|---------------|---|
| Test          | <p><b>Conclusion:</b></p> <ul style="list-style-type: none"> <li>• Results of different aquatic organisms differ</li> <li>• Results of different terrestrial organisms differ</li> <li>• Results of aquatic and terrestrial tests differ</li> </ul> <p>➔ Application of two test batteries (aquatic, terrestrial)</p> |
| Micro respi   |   |
| Micro nitrifi |   |
| Earth         |   |
| Colle         |   |
| Plant         |   |


process

ts indicate nitation

ts indicate nitation

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### Is there an added value by ecotoxicological tests?



| Test                                    | Soil 1   | Soil 2   | Soil 3                  | Soil 4            |
|---|----------|----------|-------------------------|-------------------|
| "Action" according to chemical analyses | Landfill | Landfill | Landfill                | Combustion        |
| Habitat (terrestrial tests)             |          |          |                         |                   |
| Retention function (aquatic tests)      |          |          |                         |                   |
| Comments:                               | ✓        | ✓        | Use as subsoil possible | High discrepancy! |

**Conclusion:**

- ➔ Chemical and ecotoxicological tests can differ, but they do not differ in every case
- ➔ Added value by ecotoxicological tests!

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## Ecotoxicological tests with wastes



### European Ring Test – Ecotoxicological characterization of waste

**Material:** Incineration ash  
Waste wood



**Test systems:** Aquatic tests: daphnids - immobilization,  
algae - growth,  
luminescent bacteria - luminescence  
Terrestrial tests: earthworms - reproduction,  
plants - growth

**Conclusion:**

➔ No limitations were observed for the investigated wastes and test systems

## Ecotoxicological tests with compost



**Material:** - various input (biowaste from rural and urban regions)  
- output after various composting techniques

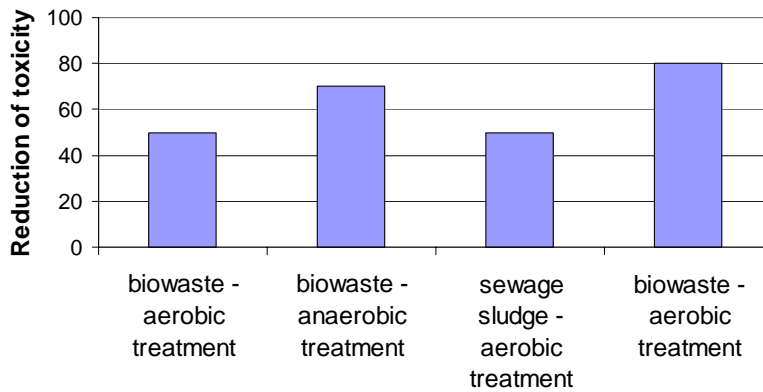
**Test systems:** - aquatic test systems – leachable portion of contaminants  
- terrestrial test systems – habitat function



## Ecotoxicological tests with compost



### Luminescent bacteria



#### Results:

- Test system applicable
- Reduction of toxicity during composting

#### But:

- Toxicity still measurable
- Reason???? (no contaminants, colour can be excluded)

## Ecotoxicological tests with compost



### Pecularity of luminescent bacteria:

- Reduced luminescence in the presence of easily degradable carbon sources
- Reduced luminescence at limited oxygen supply

### Compost eluates:

- Rich in nutrients
  - ➔ Reduced luminescence due to easily degradable carbon sources
  - ➔ Limited oxygen concentration due to degradation of easily degradable carbon sources
    - ➔ Reduced luminescence

## Ecotoxicological tests with compost



### Pecularity of luminescent bacteria:

- Reduced luminescence in the presence of easily degradable carbon sources

### Conclusion:

- **Application of the luminescence test to compost eluates is possible, but**
  - **Results have to be carefully interpreted**
  - **False positive results concerning the presence of anthropogenic contaminants cannot be excluded**

## Ecotoxicological tests with compost



### Tests with algae:

- **No assessment possible!**
- **Stimulation of growth!**  
(even when surplus in nitrogen and phosphorous is considered)

|          | Medium | Biowaste | Compost | Compost |
|----------|--------|----------|---------|---------|
| N [mg/L] | 10     | 1        | 178     | 54      |
| P [mg/L] | 10     | 106      | 13      | 13      |

- **Stimulation due to further nutrients (micronutrients?)**
- **Compensation with tolerable expenditure of time not possible**
- **Due to stimulation, relevant concentrations of undesired anthropogenic substances will not be detected**

## Ecotoxicological tests with compost



Parameter “**bioavailability**” has to be taken into account:

Compost - high content of organic matter

➤ Sorption of contaminants

➤ Reduced bioavailability

➤ Reduced / no effect detectable

| Humic acids<br>DOC | Daphnids<br>PAH - EC <sub>50</sub> |
|--------------------|------------------------------------|
| 2 mg/L             | 0.1 mg/L                           |
| 206 mg/L           | 2 mg/L                             |



Contaminants can only be detected at concentrations increasing the sorption capacity of compost (= at high concentrations)

## Ecotoxicological tests with compost



Tests with daphnids:



If detection is achieved:

- Reduction of toxicity during compost maturation

Conclusion:

- Suitable for compost assessment
- But: Immobilization is a test parameter with comparatively low sensitivity

## Ecotoxicological tests with compost

**Tests with earthworms:**  
test organism: *Eisenia fetida* (compost worm)



| Material           | Mortality [%] | Conductivity [mS/cm]<br>(indicator of salt content) |
|--------------------|---------------|---|
| Standard substrate | 0             | 0.08  |
| OL - input         | 50            | 1.46  |
| OL - compost       | 100           | 2.04  |
| FR - input         | 45            | 0.70  |
| FR - compost       | 15            | 0.75  |

✚ High toxicity due to unfavourable salt content

✚ Leaching improves the habitat function

## Ecotoxicological tests with compost



### Conclusion:

In contrast to soil, ecotoxicological assessment of compost is often dominated by indicating natural components at unfavourable concentrations

✚ Are ecotoxicological analyses unsuitable for composts?  
or  
Do we have to modify our point of view?



## Ecotoxicological tests with compost

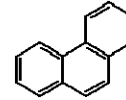


### In general:

Organisms indicate unfavourable conditions, independent of their origin

### Decision:

Do I want to detect anthropogenic contaminants in composts?



- ➔ Depending on the maturation level of the compost, ecotoxicological tests can be less suitable

### General assessment of compost

- ➔ Ecotoxicological tests are suitable



- ☛ Testing of pure compost (100 % compost) – information on the material
- ☛ Testing mixtures of soil and compost - information on effects at environmentally relevant conditions

## Ecotoxicological tests with compost

Thank you for your attention!

