Black Soldier Fly facilities in temperate and cold climate – important factors to be a climate friendly alternative in waste management

Workshop: Opportunities in Waste Sector and Agriculture: Animal Feed from Organic Waste, the climate-friendly Way - Black Soldier Fly

Online event, 16/05/2022
Project Overview

Identification of criteria for other high-quality recycling of organic waste
(Ermittlung von Kriterien für hochwertige anderweitige Verwertungsmöglichkeiten von Bioabfällen)

Project duration: 24/04/2018 – 31/10/2020

Project consortium: Öko-Institut e.V. u.e.c.

Funded by the German Environment Agency (UBA)
(FKZ 3717 34 341 0)
Black Soldier Fly Larvae – Process Profile

Use of biomass-containing waste for breeding black soldier fly larvae

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Air humidity</th>
<th>Light exposure</th>
<th>Cycle duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 – 30 °C</td>
<td>Approx. 60 %</td>
<td>Min. 500 W/m²</td>
<td>Approx. 30 d</td>
</tr>
</tbody>
</table>

Suitable input materials: Organic waste (kitchen and food waste), organic residues from industry / agriculture
Black Soldier Fly Larvae – Mass Balance

- **Challenges:** Hygiene is very important! Feed law restricts economic breeding

- Material recovery
  - Larvae meal as feed (permitted in EU for aquaculture)
  - decomposed waste and larval rot as compost

Adjustment of the water content (approx. 60 - 80 %) ensures a high decomposition rate of the organic waste.

Conversion of waste to biomass: $2 : 1 - 3 : 1 \frac{kg_{organic, DS}}{kg_{larvae, DS}}$

BSF breeding
- Energy: 161 kWh/Mg Input
- Heat: 3404 kWh/Mg Input

Process gas: 33 kg
Larvae return
Larvae meal: 120 kg
Larvae fertiliser: 667 kg

Waste water: 1074 kg
Residues: 6 kg

Org. residues: 1000 kg
Substrate: 6 kg
Water: 889 kg
Peroxyacetic acid: 5 kg
Black Soldier Fly Larvae – State of Development

State of development and plants

- In Germany, there are only smaller plants in operation so far; internationally, there are a small number of plants on an industrial scale; R&D is going on.
- Lack of assessment of the impact of economic breeding on the biological activity of the soldier fly and interactions with the environment.
- Examples of plants:

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Substrate</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AgriProtein</td>
<td>South Africa</td>
<td>Household waste</td>
<td>91,000 Mg/y</td>
</tr>
<tr>
<td>Enterra Feed</td>
<td>Langley, Canada</td>
<td>Biowaste</td>
<td>36,000 Mg/y</td>
</tr>
<tr>
<td>Hermetia</td>
<td>Germany</td>
<td>Rye grist</td>
<td>350 Mg Larvae meal/y</td>
</tr>
<tr>
<td>Nextprotein</td>
<td>France/Tunisia</td>
<td>Food waste</td>
<td>5-10 Mg/d</td>
</tr>
</tbody>
</table>
Phases of LCA Studies

1. Goal and scope definition
2. Inventory analysis
3. Impact assessment
4. Interpretation

Double arrows stand for an iterative approach
Brief description of the individual steps

1. **Goal and scope definition**
   Definition of the goal and the scope of the study

2. **Inventory analysis**
   Compilation of environmentally relevant inputs and outputs

3. **Impact assessment**
   Assessment of the potential environmental impacts and weighting of the different impact criteria against one another (optional).

4. **Interpretation**
   Summary of the results of the life cycle inventory and the impact assessment according to the goal definition.
Basics of BSF LCA I

- Average electricity mix of Germany in 2020
- Biogenic CO₂ was not accounted for
- Inventory data from procedure description

Scope

Functional unit
Recycling of 1 Mg organic waste

Inputs e.g. heat

Treatment e.g. BSF plant

Outputs e.g. larvae

Emissions e.g. waste water

Product utilisation e.g. production of larvae meal

Outputs e.g. protein feed

Emissions e.g. methane

Credits e.g. protein feed
Basics of BSF LCA II

- Database ecoinvent 3.4 APOS
- Impact assessment method ReCiPe 2016 Midpoint (H)

Impact categories

- Climate change (GWP in kg CO₂-eq)
- Terrestrial Acidification (AP in kg SO₂-eq)
- Freshwater Eutrophication (EP in kg P-eq)
- Ozone formation (POCP in kg NOₓ-eq)
- Terrestrial Ecotoxicity (in kg 1,4-Dichlorbenzol (1,4-DCB))
- Fossil resource scarcity (in kg oil-eq)
- Mineral resource scarcity (in kg Cu-eq)
- As separate method: CED (Cumulate Energy Demand, fossil) (in MJ)
LCA results – Climate change

Composting: 25 kg CO$_2$-eq/Mg biowaste
Biogas plant: -75 kg CO$_2$-eq/Mg biowaste
LCA results – Acidification, Eutrophication, Ozone Formation, Terrestrial Ecotoxicity

Acidification

- with heat
- w/o heat
- sum with heat
- sum w/o heat

Eutrophication

- with heat
- w/o heat
- sum with heat
- sum w/o heat

Ozone formation

- with heat
- w/o heat
- sum with heat
- sum w/o heat

Terrestrial ecotoxicity

- with heat
- w/o heat
- sum with heat
- sum w/o heat
LCA results – Fossil Resource Scarcity, Mineral Resource Scarcity, Cumulative Energy Demand
Conclusion

Soldier fly larvae represent a promising process, if at least one of the following options is possible

• the high demand for heat can be met from process waste heat
  → choice of a suitable location e.g. near a MSW plant or a biogas plant with CHP to use waste heat
• sufficient insulation of the building envelope
• use of renewable energies for heat supply e.g. solar thermic installations
Thank you very much for your attention