The potential of treating human faeces with black soldier fly larvae

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Current status – Room for improvement

**Excreta treatment**
- High cost for emptying and treatment of on-site sanitation systems
- Uncontrolled disposal → Spreading of diseases

**Agriculture**
- Depleting soil fertility → Low crop yields
- High cost fertilisers

**Animal feed protein**
- High cost of animal origin proteins, fish meal most commonly used
  → Over fishing → Price increase

**Using the larvae of the black soldier fly**
- Animal feed production directly from human excreta
- Degradation of faecal matter → Fertiliser
- Sanitisation of excreta
The Black Soldier Fly (BSF)
*Hermetia illucens* L.
(Diptera: Stratiomyidae)

*About 18 mm long*

*Found between 45°N and 40°S*
**Why the BSF?**

**The BSF life cycle**

1. **Egg**
   - Every female lays 1,000 eggs
   - **Rapid reproduction**

2. **Larva**
   - Feeds on household waste or animal/human excrements
   - **Waste treatment**

3. **Prepupa**
   - Migrates from the waste in search for a dry pupation site
   - **Self harvesting, protein rich product**

4. **Pupa**
   - Adult emerges after two weeks

5. **Adult**
   - Does not feed
   - **No carrier of diseases**

**1 month**

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- Prepuca migrates from the waste in search for a dry pupation site. 
- Self harvesting, protein rich product.
- Adult emerges after two weeks.
- Every female lays 1,000 eggs, leading to rapid reproduction.
- Larva feeds on household waste or animal/human excrements, leading to waste treatment.
- Adult does not feed, making it a non-carrier of diseases.
The BSF larvae – Three benefits

1. Good as animal feed
   - 36-48% protein
   - 31-33% fat

2. Crawl out of the feed material
   - Self-harvesting
     → greatly simplified production technology

3. Known to inhibit oviposition of the common housefly
   - Reduce risk of vector bound diseases spreading
The BSF treatment technology

1. Excreta collection
2. BSF conversion technology
   - Prepupae
   - Residue
   - Hygienic status
   - Is post treatment necessary?
3. Animal feed
4. Agriculture

Money
Research questions:

- How safe is the use of BSF prepupae in animal feed when fed human faeces?
- Does the feeding activity of BSF larvae reduce pathogens present in the residue?
Experimental set-up

Indicators and pathogens
a) *Salmonella* Typhimurium
b) *Enterococcus faecalis*
c) Bacteriophage φX174
d) *Ascaris suum*

Faeces
BSF larvae
Prepupae
Analysed for pathogen and indicator presence

BSF composting
Residue
Pathogen and indicator concentrations monitored as a function of time
Pathogen reduction - Residue

Inactivation in BSF-treatment unit (squares) compared to storage (triangles)

Salmonella spp.

Enterococcus spp.

φX174

d) No reduction in concentration of *Ascaris suum* eggs
No effect on the inactivation of *Ascaris suum* eggs
Pathogens in prepupae

Inside the prepupae

- **Salmonella spp.**
  - High in substrate, when found in larvae, only in small concentrations
- **Ascaris**
- **Enterococcus spp.**
  - $3\log_{10}$ less than input material
- **Bacteriophage фX174**
  - $4\log_{10}$ less than input material

Fractions in a BSF-treatment unit

- Organic waste, e.g. human faeces
- BSF compost
- Prepupae
- Treatment residue
Conclusion Residue

- A $7\log_{10}$ reduction of *Salmonella* spp. in eight days
  - Reduced risk of disease transmission between humans and animals

- No effect on *Enterococcus* spp., *Ascaris suum* and bacteriophage $\phi X174$
  - Additional treatment required if spread on food crops, *e.g.* ammonia sanitisation
Conclusion Prepupae

- Pathogens and indicators found inside prepup

→ Pretreatment of prepupae prior to animal feeding, e.g. drying
The BSF treatment technology

- Proteins directly from waste
  - Does not go via field \(\rightarrow\) Smaller losses

- Treatment residue to fields
  - Great reduction of mass volume \(\rightarrow\) Simplify post-treatment

- Economic incentive for community to collect human and animal manure
  - Decrease disease spreading

GREAT POTENTIAL!