Bioconversion of waste paper by termites: a landfill of opportunity

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Background

Waste paper is in large supply in landfills and increasing daily; especially where recycling is not economically feasible. Since termites obtain most of their energy requirements from the digestion of cellulose, there is an opportunity to utilise their services to break down this waste paper and utilise the resulting termite biomass as a food source for the aquaculture, pig, and poultry industries. Nutrients left behind in termite wastes may also be useful for horticultural purposes, particularly compost.

Purpose & Hypothesis

This project aims to look at the feasibility of this idea, with emphasis on application in remote locations where paper recycling is not otherwise commercially feasible, as recommended by the Desert Knowledge Cooperative Research Centre, centred in Alice Springs, Northern Territory.

Materials & Methods

This project commenced with a pilot study in Perth, using a colony of *Coptotermes acinaciformes* in a termitarium. The attractiveness to termites of different types of waste paper encased in 3-litre plastic containers was evaluated in trial 1, and a mixture of paper types with different moisture levels in trial 2. The decomposed remains and soil in the laboratory containers were evaluated for nutrient content via two pot trials and CSBP analyses. Then, next to the landfill of Alice Springs, the trial was extended to a large-scale field evaluation, using 44-gallon drum feeding stations exposed to *C. acinaciformes*.

Figure 1. *Coptotermes acinaciformes* (soldier and worker)

Figure 2. Termitarium bed with sample containers

Figure 3. Subterranean termite feeding station

Figure 4. Cardboard activity-indicators with *Coptotermes acinaciformes*

Results

Pilot Study

- *C. acinaciformes* showed preference for newspaper over glossy-coated paper, and glossy over bleached office paper.
- Added moisture increased the overall decomposition rate, but dry paper was preferred over saturated samples.
- Termites in a 1 m^3 soil bed of the termitarium decomposed 5.9 kg (dry wt.) paper in trial 1 and 6.9 kg in trial 2 over 20 weeks.
- As the termites decomposed the paper, soil and moisture were incorporated in the pack.

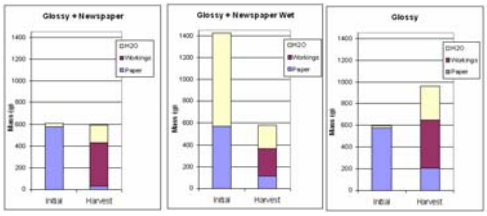

Figure 5. Average mass of paper, workings, and water before (initial) and after (harvest) 20 weeks exposure to a captive colony of *C. acinaciformes*.

Figure 6. Remaining termite workings

- Mixing workings into a sand and peat control (1:1) increased the soil pH from 4.96 to 8.18 and conductivity from 0.08 to 0.25 dS/m.
- The workings mix revealed low levels of nitrogen and high levels of phosphorus, potassium, sulphur, organic carbon, and the trace elements copper, zinc, manganese, and iron.
- Addition of nitrogen (urea) to the workings increased plant productivity substantially.

Large Scale Study

- 8 of the 10 drums were active after one month.
- Although the feeding stations were successful in focusing feeding activity, decomposition of the paper in the plastic bags was relatively low.
- The most successful bag revealed 561.6 g decomposed paper (20.8 %) over 20 weeks.

Figure 7. Termite workings from inside the feeding stations.

Conclusions

- Subterranean termites are effective in decomposing waste-paper.
- The remaining workings may be beneficial in horticulture as a source of phosphorus, organic carbon, and trace elements as well as increasing the pH of acidic soils.
- Further research is recommended into designing simple infrastructure that creates favourable conditions for the termites and is easy to harvest remains and termite biomass.
- The technology may be more effective in areas which house the giant northern termite: *Mastotermes darwiniensis*.

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