# Microbial enzyme activities during microbial turnover of organic carbon substrates in soil

Denise Vonhoegen, Ubaida Yousaf, Sören Thiele-Bruhn
Trier University, Faculty of Regional and Environmental Sciences (VI), Department of Soil Science, Trier, Germany
**Contact:** vonhoegen@uni-trier.de

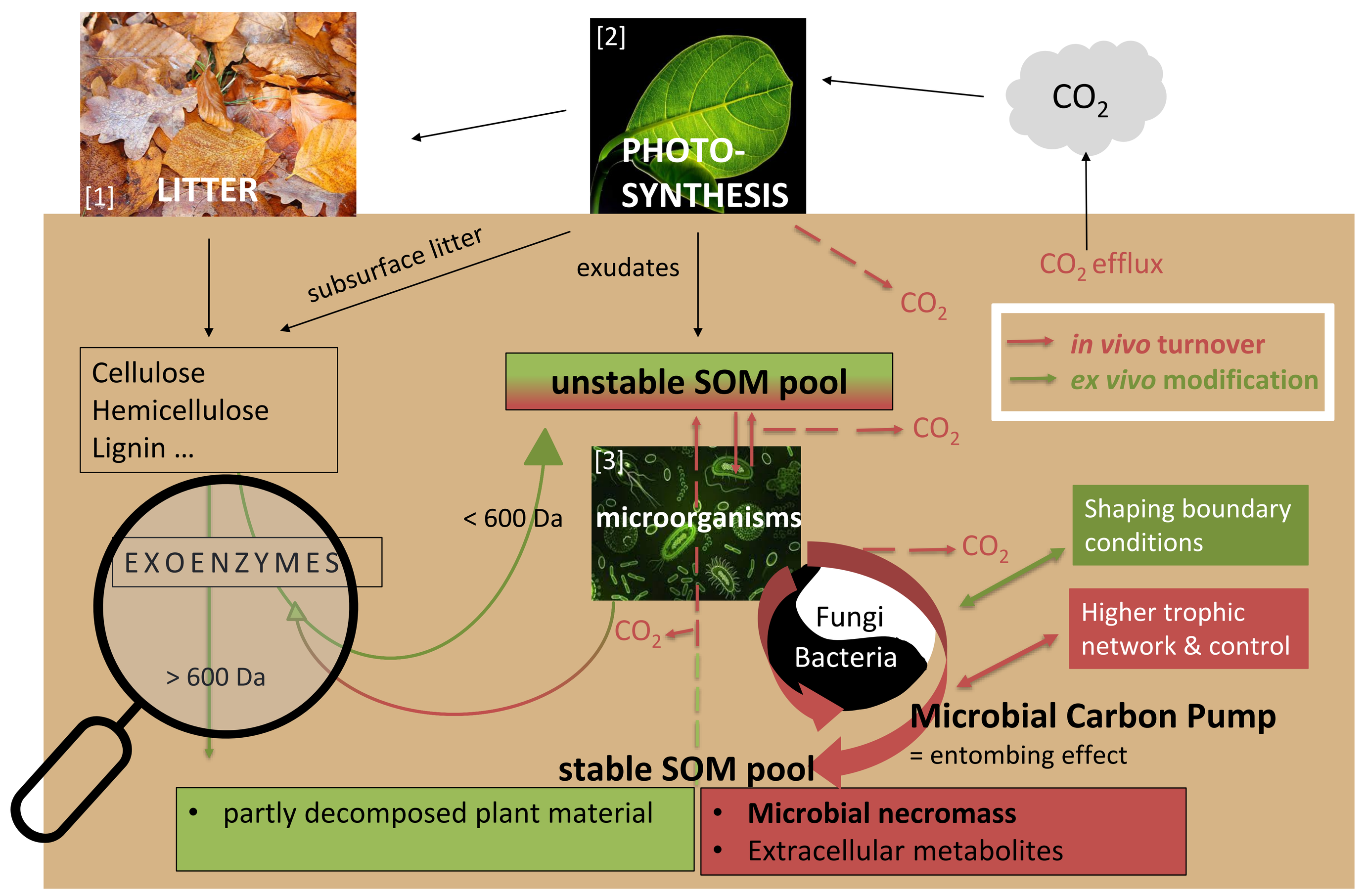



**Fig 1: Schematic overview of microbial processes in soil related to energy cycling and C metabolism.** Figure modified from Liang et al., 2017.

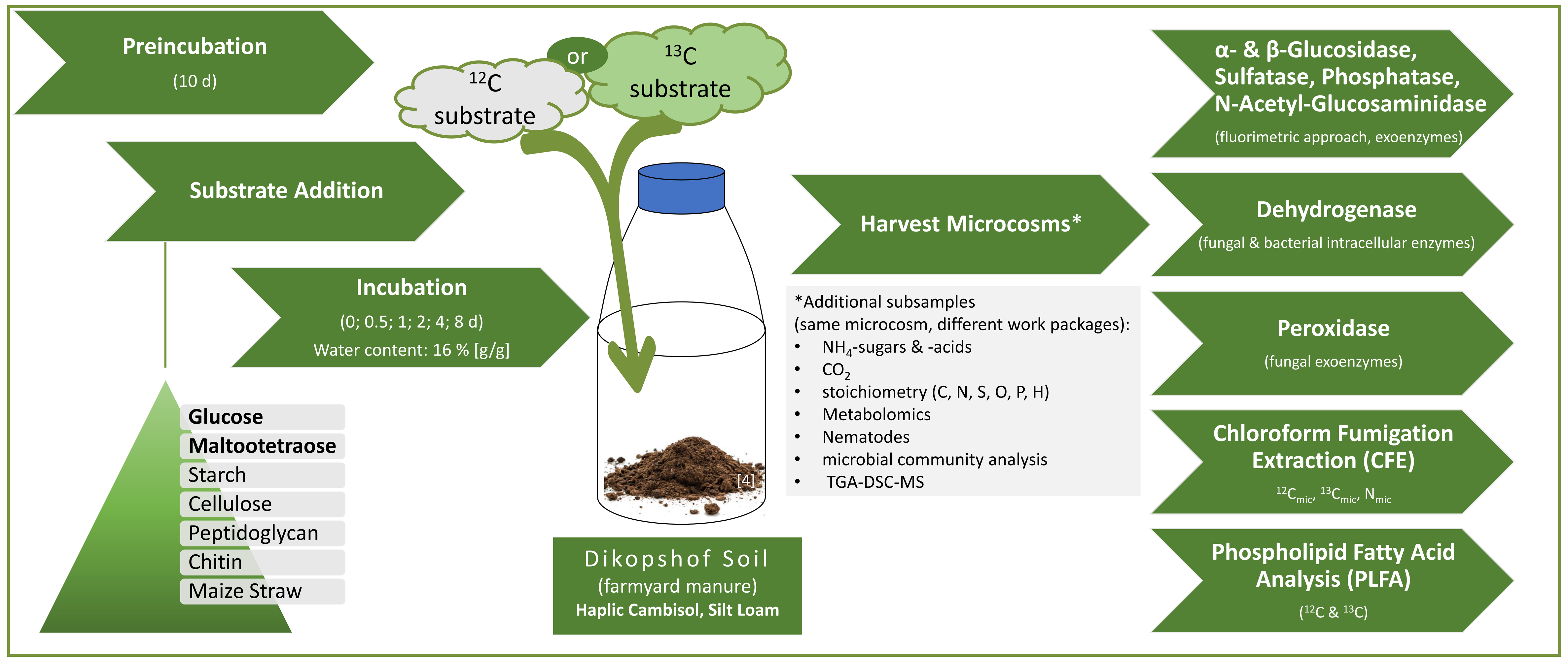
## 1. Introduction & Hypotheses

***DriverPool,*** as sub-project of the Priority Program **SoilSystems,** focuses on the effect of organic carbon substrates with different **rigidity, size** and **complexity** on **carbon turnover** in soil. **Batch Incubation** Experiments are performed to investigate the influence of substrate and existing soil organic matter (SOM) on **energy** and **mass balances** as well as **microbial activity** and **community** composition. Here, first results of microbial enzyme activities after amendment with **glucose** (**Gluc**; 180 Da) and **α-1,4-Maltotetraose** (**Malto**; 666.6 Da) are presented.

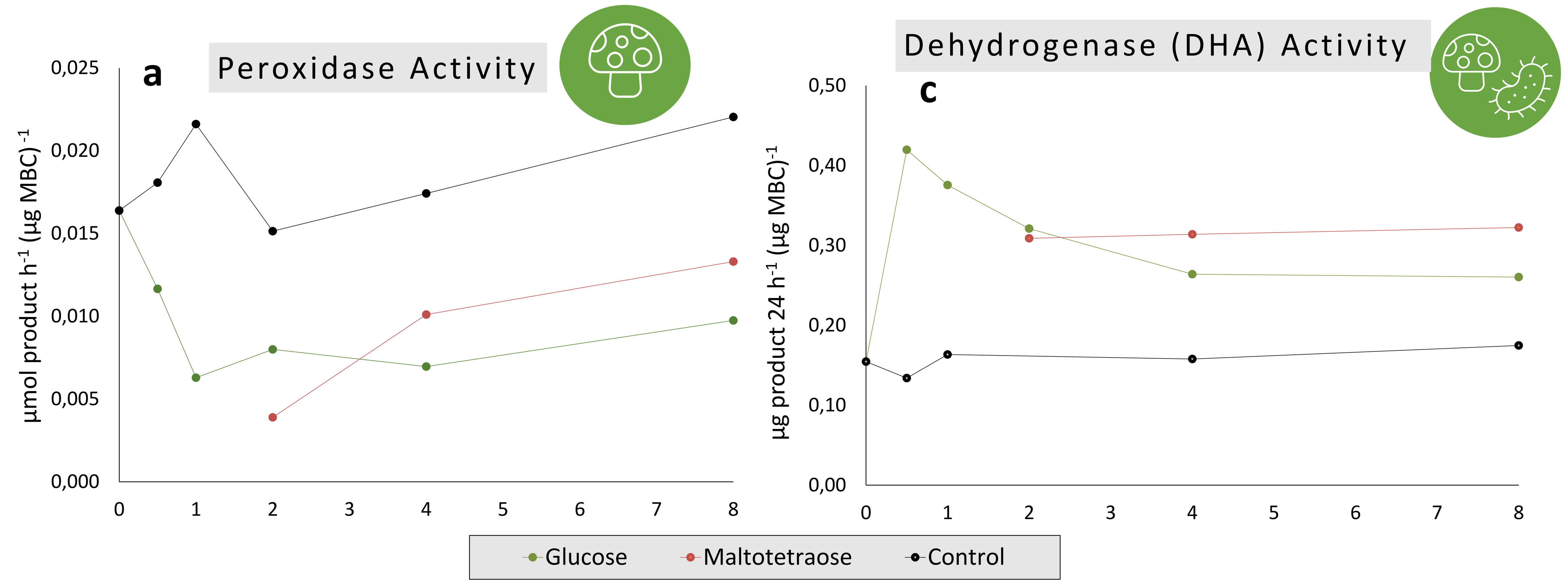
**Hypotheses:**

- Malto turnover requires exoenzyme activity due to molecular size > 600 Da
- Malto follows an adaptation-oriented process while Gluc pursues a growth-oriented process
- Malto and Gluc possess different carbon & energy use efficiencies (CUE, EUE) due to different pathways in soil (Fig. 1)

## 2. Methods




## 3. Preliminary Results



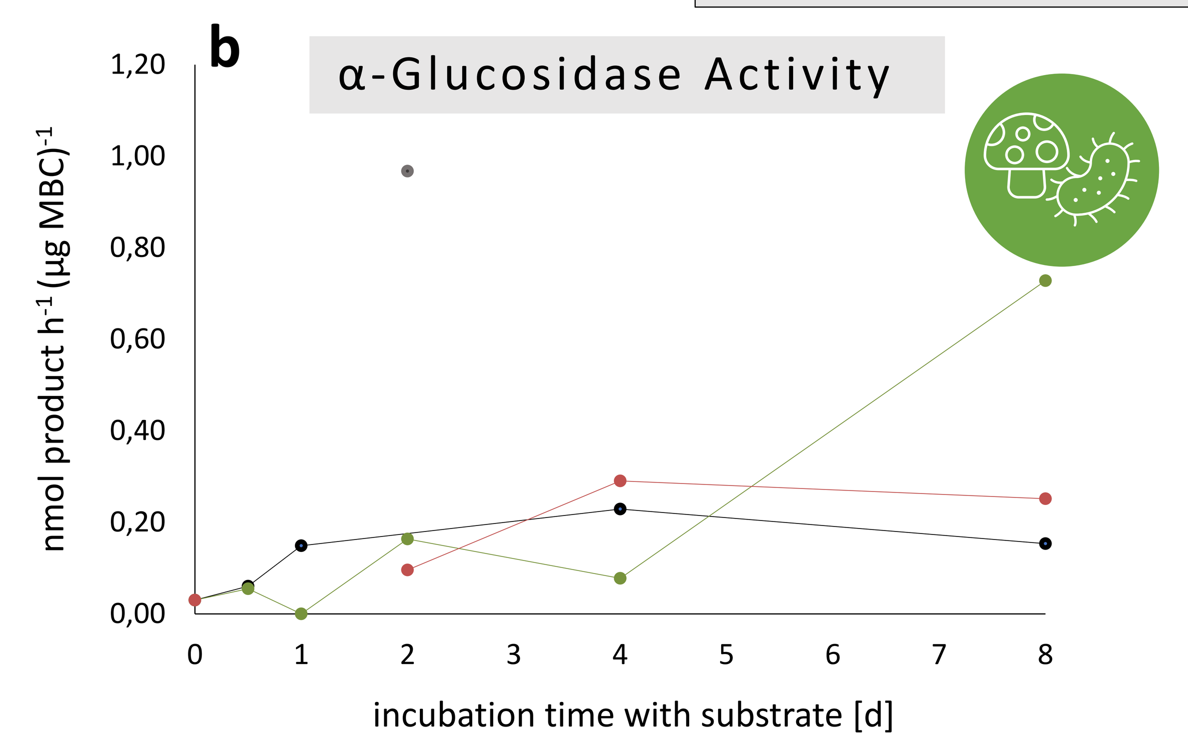




**Fig. 2a-c: Biomass specific enzyme activities** as mean values (n =3) obtained from incubation experiment (0-8 days). Substrate addition: 4x 178 µg MBC (g soil)$^{-1}$ related to substrate-C; water content: 20 % [g/g]; Soil: Dikopshof soil treated with farmyard manure. Control = unamended soil.

- **Peroxidase** activity decreases with addition of sugars
- **α-Glucosidase** activity is highest in Malto treatment at 4 d and 8 d incubation
  → Malto = 4x α-glycosidic bonded Gluc molecules
- Strong increase in **α-Glucosidases** after 8 d with Gluc addition
- Highest **DHA** activity in Gluc amendment during first 2 d but higher in Malto samples after 4-8 d

## 4. Discussion

- **Peroxidases** are involved in organic matter degradation & catalyze release of carbohydrates & proteins by $H_2O_2$ dependent breakdown of aromatic polymers (Tian et al., 2014)
- **Malto turnover** is apparently **delayed** → preceding split-up of α-1,4 glycosidic bonds required that yields 4 glucose molecules = higher DHA activity (Fig. 2c: 4 d & 8 d)
- The **carbon use efficiency** (CUE) of Malto may be lower to the one of Gluc; compensating this cost, other carbon sources of the soil are mined
- Gluc addition induces **highest increase in α-Glucosidase** activity after 8 d (Fig. 2b) → competition between microorganisms after Gluc depletion or consumption of necromass/other resources?

## 5. Conclusions

- ✓ **Substrate dependent shift in microbial enzyme activties**
- ✓ **Peroxidase** activity is reduced in both sugar amendments, which may indicate a preference for easily degradable carbohydrates
- ✓ **exoenzyme activity** required to degrade Malto→ **higher investment** needed for exoenzyme production, but four glucose molecules as return on investment
- ✓ **Increased dehydrogenase activity** indicates that Gluc and Malto are both nutritional sources that **enhance metabolic activity** compared to unamended soil

## 6. Outlook

Need for further information to validate first conclusions & hypotheses

- ? Shifts in **community composition** (PLFA pattern)
- ? Role of **necromass** (aminosugars and –acids)
- ? Activity of DHG and exoenzymes at the start of Malto turnover

**What comes next?**

Experiments with **starch** and **cellulose** to investigate the effect of substrate rigidity and complexity (α-1,4- vs. β-1,4-glycosidic bond)

**References**

Liang, C., Schimel, J. P., & Jastrow, J. D. (2017). The importance of anabolism in microbial control over soil carbon storage. *Nature microbiology*, *2*(8), 1-6.

Tian, L., & Shi, W. (2014). Soil peroxidase regulates organic matter decomposition through improving the accessibility of reducing sugars and amino acids. *Biology and fertility of soils*, *50*, 785-794.

Image Sources
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