UNIVERSITY OF COPENHAGEN
DEPARTMENT OF PLANT- AND ENVIRONMENTAL SCIENCE

Recycling of food-processing residues and the effect on soil health

Eva Faurholdt Vistisen[a*], Sander Bruun[a] & Veronika Hansen[a]
Department of Plant and Environmental sciences, University of Copenhagen, Denmark [a]

*Corresponding author:
Eva Faurholdt Vistisen
efj@plen.ku.dk.

Background and objective

Soil health and nutrient availability are key for sustainable crop production. Pot trials assess plant responses, while incubation studies reveal microbial processes affecting nutrient dynamics without interference of plants. This study combines both approaches to evaluate the nutrient fertilizer replacement value (NFRV) of different soil amendments based on food-processing residues and their effects on soil health parameters, aiming to identify products that optimize both soil health and decrease the need for mineral fertilizer.

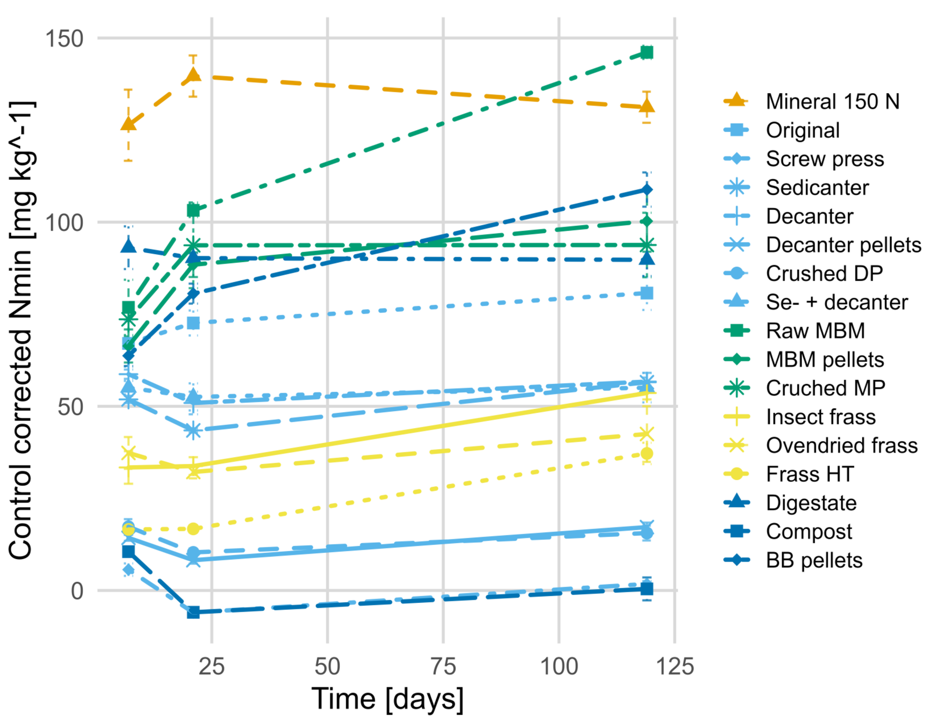
Food-processing residues (FPR) often require further treatment to be safe to use and easily applicable. Can treatment improve both applicability and soil health parameters without compromising nutrient availability?

Materials and method

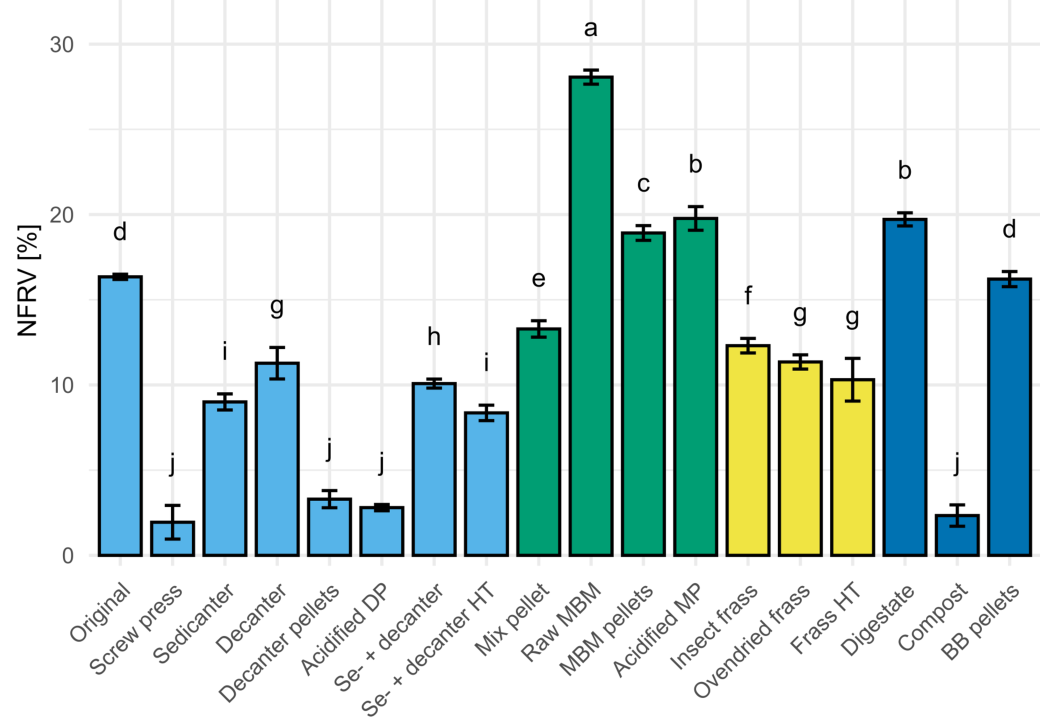
Pot experiment, spring barley, 46 days FPR products added corresponding to 150 kg N ha^{-1}	Incubation study, three timepoints, 119 days FPR products added corresponding to 150 kg N ha^{-1}
Chlorophyll index	Mineral N (Nmin) at three timepoints
Biomass	pH + electrical conductivity (EC) at three timepoints
Total N	Water holding capacity (WHC)
pH	Substrate induced respiration (SIR)
Electrical conductivity (EC)	Soil microbial biomass C (SMB-C)

Pot experment with barley plants one day before harvest (left) and the setup of the aerobic incubation study (right).

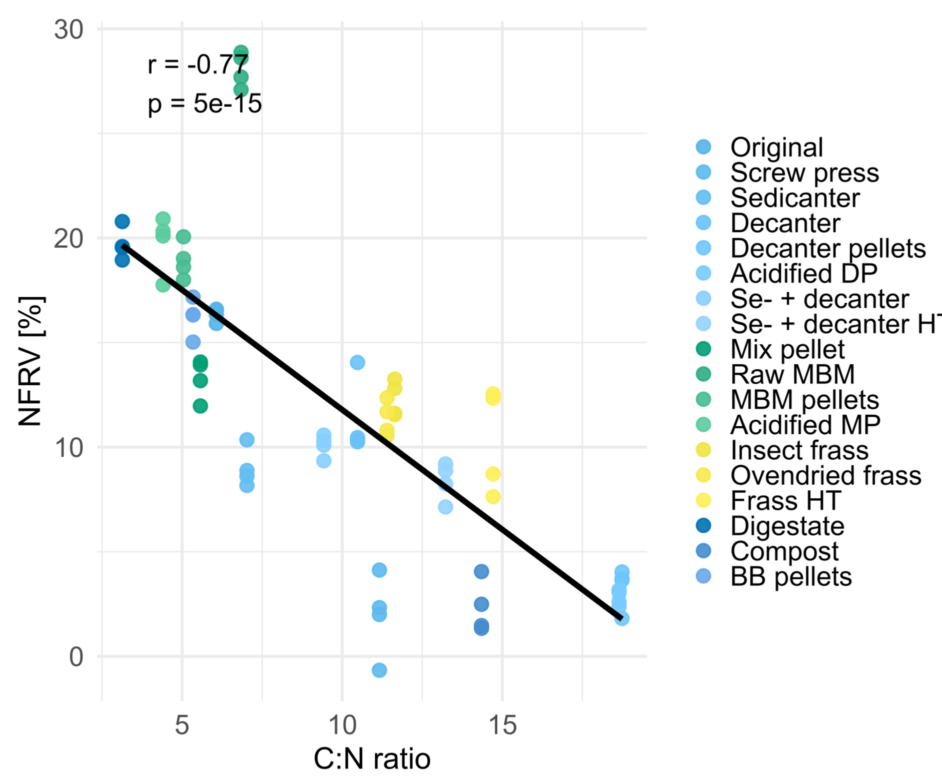
Results



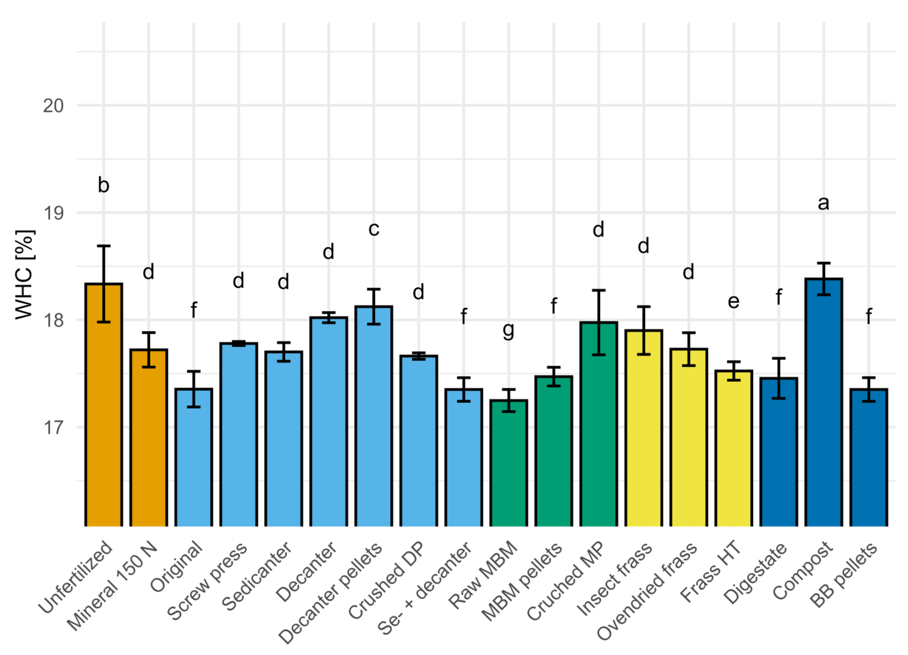
Nmin at three timepoints show a decrease in minerally added N after day 21. Several biobased treatments decrease between day 7 and 21 but stabilises or increase at different rates after day 21, and raw MBM exceeding mineral fertiliser at day 119.



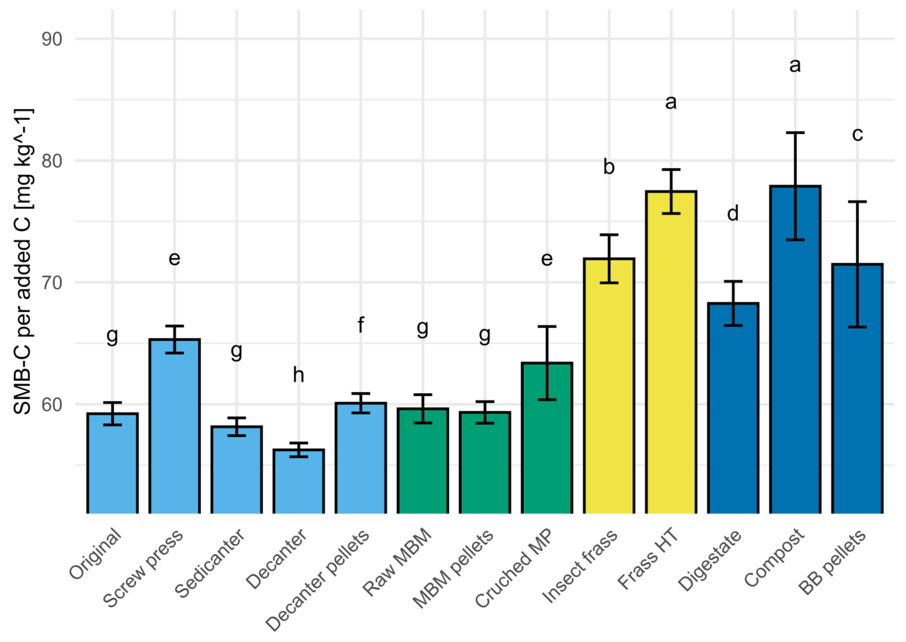
Generally, treatment of raw material decreases NFRV. Screw press fibre and decanter pellets have the lowest NFRV and are similar to compost. MBM have higher NFRV than digestate and frass.



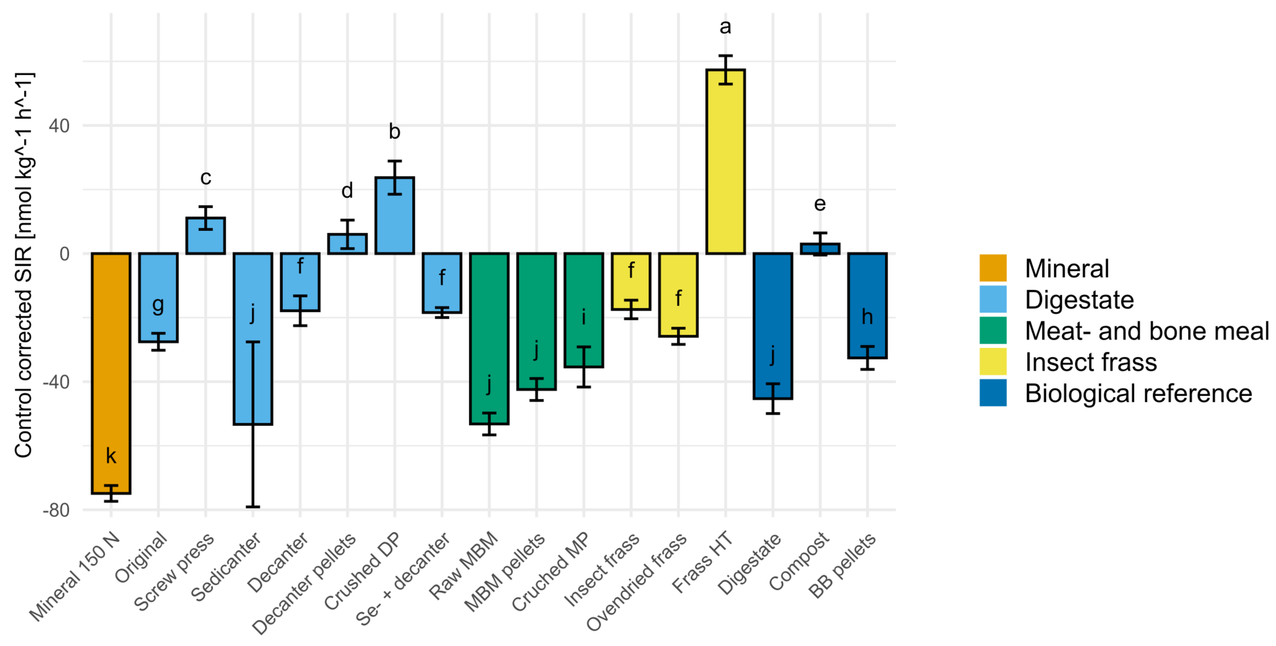
The NFRV correlates negatively with the C:N ratio – the higher C:N ratio, the lower NFRV.



Separation of digestate increase WHC except for decanter and sedicanter mix. Pelleting of decanter fibre also increases WHC. The crushing of decanter fibre pellets decrease WHC while crushing of MBM pellets increase. Hygienization of frass decreases WHC



Hygienised frass and compost have the highest concentration of SMB-C. Of digestate derived treatments, screw press fibre have the highest concentration, and decanter fibre have the lowest. Pelleting of decanter fibre increase SMB-C, for MBM pelleting have no significant impact.



Screw press fibre, decanter pellets, and hygienised frass have increased SIR relative to the unfertilised control. Separation technique of digestate cause large variation. Hygienization of insect frass have the highest positive impact

Key findings

- The NFRV of the FPR derived products vary between 2 and 28% after 46 days, yet the mineralization of FPR products continues where mineral added N stabilizes.
- Total added N is the same across all FPR treatments, so variations in C:N ratios are due to differences in C content. High C content limits mineralization of N thus decreasing NFRV.
- For digestate, MBM and frass, NFRV decreases with further treatment, but generally further treatment causes increase in soil health parameters.

- Applicability and soil health parameters can improve simultaneously but at the expense of N availability.

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