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Energy content and structural changes in energy crops under landfill leachate irrigation

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Introduction

Willows and poplars have been used for recultivation of landfill sites under landfill leachate irrigation (Hasselgren, 1992; Lee and Woo, 1998). Plants are used as a carbon neutral energy source, beside their contribution to treatment and minimization of the landfill leachate and stabilisation of the recultivation substrate. In a six month pot experiment, *Salix viminalis* L., *Salix caprea x cinerea*, *Salix purpurea* L. and *Populus nigra* L. were screened for their suitability for revegetation under landfill leachate irrigation. Irrigation of landfill leachate, which contains - among other compounds - high salt (NaCl) and ammonium concentrations, led to (1) increased biomass production at first possibly owing to N input, (2) followed by diminished growth, necroses and loss of turgor probably owing to stress caused by the high NaCl input, (3) increased plant water content and (4) an increase in water soluble Na^+, Cl^-, NO_3^- and total N content in the plants (Watzinger et al., 2002).

Core

The observed changes raised the question of changes in the energy content and structure of the wood, which are investigated by simultaneous thermal analysis (STA) and infrared spectroscopy (FTIR). Stem material was dried and ground and 10 mg sample was oxidized in a dry air atmosphere at 60 ml min^{-1} at a heating rate of 5 K min^{-1} in a STA 409 PC Luxx (Netzsch, Germany). The differential scanning calorimetry generated three exothermic peaks with a peak maximum at 575 K, 656 K and 697

K and a trend towards lower peak temperatures in landfill leachate irrigated samples. The peak area at 575 K was not influenced by landfill leachate irrigation, while energy output decreased at 656 K and increased at 697 K. The total energy content of the wood was not affected by landfill leachate irrigation. Differences between plant species were visible in the burning profile, but were only rarely reflected in the peak areas and peak temperatures. The three peaks might be interpreted as the successive oxidation of the three main wood compounds hemicellulose, cellulose and lignin (Orfao and Figueiredo, 2001). Correspondingly, landfill leachate irrigation might have trigger lignin production. This assumption was not verified in the first samples measured by IR. Other compounds than lignin might be co-responsible for the peak at 697 K, or the attribution of the peaks must be challenged. Decreasing peak temperatures under landfill leachate irrigation might be attributed to the effect of elevated NaCl contents, which might act as a catalyst as suggested by Varhegyi et al. (1998).

Conclusion

To conclude, landfill leachate irrigation caused changes in the wood structure, causing a shift from compounds with a peak temperature of 656 K to compounds, which are oxidized at 697 K, while it did not influence total energy content, which emphasis the importance of biomass production for energy production.

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