Title

"Improving the calorific value and overall combustion characteristics of *Miscanthus* by adding biomass of certain perennial herbaceous wild plant species"

Authors

Von Cossel, M. [1], Lebendig, F. [2], Iqbal, Y. [3], Müller, M. [2] and Jablonowski, N.D. [4]

Affiliation

[1] University of Hohenheim, Institute of Crop Science, Biobased Resources in the Bioeconomy (340b), Stuttgart, Germany, moritz.cossel@uni-hohenheim.de

[2] Institute of Energy and Climate Research, IEK-2, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany, mic.mueller@fz-juelich.de, f.lebendig@fz-juelich.de

[3] College of Bioscience and Biotechnology, Hunan Agricultural University, Changsha 410128, China, yasir.iqbal1986@googlemail.com

[4] Institute of Bio- and Geosciences, IBG-2: Plant Sciences, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany, n.d.jablonowski@fz-juelich.de

Keywords

Agrobiodiversity; Ash melting behavior; Bioenergy cropping system; C4 grass; Environmental services; Perennial biomass crop; Solid biofuel; Wild plant species; Wildflowers.

Aim and approach used:

Miscanthus (ANDERSSON) is a promising perennial industrial crop whose biomass can be used for both bioenergy and biobased products. In view of increasing land use conflicts between food crop cultivation, nature conservation and urbanization, it is a positive aspect that the cultivation of *Miscanthus* can be carried out on so-called marginal agricultural areas. However, *Miscanthus* inflorescences do not provide nectar or pollen, so diversification measures are required to increase the biodiversity supporting ecosystem services of *Miscanthus*-dominated regions. The co-cultivation of perennial flower-rich wild plant species (WPS) could function as biodiversity hotspots in these regions. Furthermore, *Miscanthus* and the WPS biomass have already showed high suitability for combustion. However, it is still unknown how a substrate mix of *Miscanthus* and WPS performs qualitatively. This study assesses the effects of mixing the biomass from WPS and *Miscanthus* on the calorific value and the overall combustion characteristics. Plant material from a long-term field trial in Southwest Germany was used for analyzing both higher heating value, ash melting behavior, lignocellulosic composition and relevant macro and trace elements. The biomass yield was not considered in this study.

Scientific innovation and relevance:
The innovation of this study lies within the concept of improving the overall ecosystem service performance of *Miscanthus* cultivation at farm scale, especially with regard to biodiversity friendliness, through agricultural diversification. The results are relevant because they show the possibility to improve both ecosystem services and biomass quality by combining different types of plant biomasses. This will demonstrate the potential synergies between ecosystem services and economic feasibility in biomass production.

Results and conclusions:
As expected, the addition of WPS biomass did not affect the calorific value of *Miscanthus* biomass, but it improved the overall combustion characteristics of *Miscanthus* biomass. The latter was indicated by both an improved ash melting behavior and an increase of the calculated critical temperature (when 100% of ash is molten). For example, the addition of 30% common tansy (*Tanacetum vulgare* L.) dry matter biomass to *Miscanthus* dry matter biomass resulted in an increase of the critical temperature from 1000 °C to 1200 °C. These results indicate that the addition of biomass from WPS like common tansy could reduce maintenance costs of incineration plants and thus compensate for lower biomass yield levels compared with *Miscanthus*. Consequently, this study provides an example for how to improve overall ecosystem services of biomass production at farm scale without impeding economic feasibility, and thereby contributing to the development of a sustainable bioeconomy.