



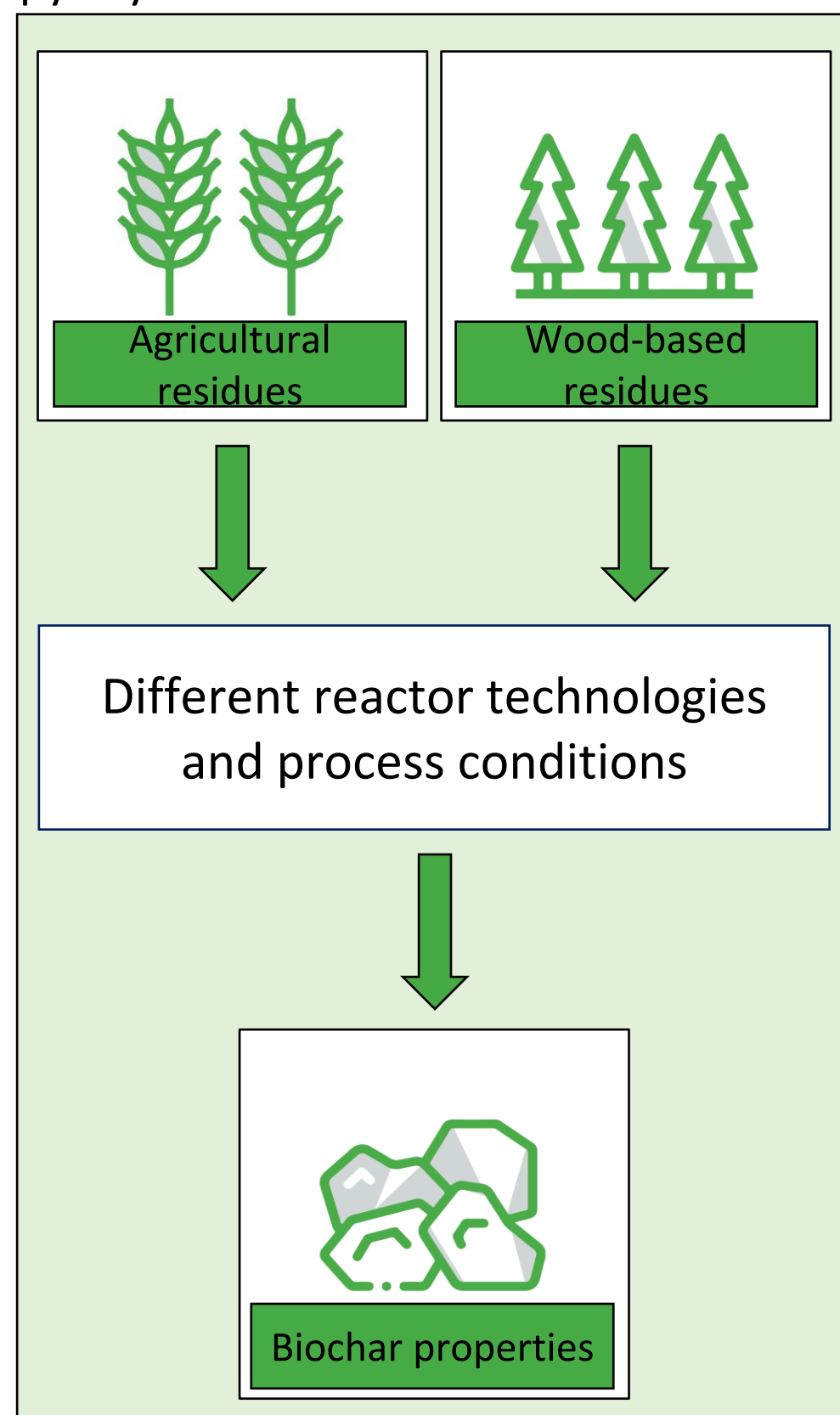
Feedstock, process and reactor technology as degrees of freedom to adjust properties of biochar in a controlled way

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Area 1.1 Thermochemical Technologies

Introduction

In recent decades, Biomass gained attention as a source for renewable Carbon, as well as a tool for CO₂ emission reduction. One technology to transform biomass into a more stable Carbon product is pyrolysis. While pyrolysis of biomass yields several different product fractions, the most known one is probably biochar. Biochar as a carbonaceous, black material has been known for Millennia as a solid fuel. However, as recent research explored a multitude of industrial and agricultural applications, it became clear that no two biochars are equal and these differences in physico-chemical properties strongly determine the suitability for a given application. Thus, deliberate manipulation of these properties has become a focal point of pyrolytic research.



General conclusions

Biochar properties can be heavily influenced using different variations of feedstock, reactor and process combinations. **While feedstock and reactor choice set the underlying frame for the produced biochar, the process conditions give biochar properties a broad range within that frame.** Given the fact that the various applications of biochar require different biochar types, the results show that these requirements can be fulfilled through careful case-specific biochar designing.

Article 1: Moser K, Wopienka E, Pfeifer C, Schwarz M, Sedlmayer I, Haslinger W. **Screw reactors and rotary kilns in biochar production – A comparative review.** J Anal Appl Pyrolysis. 2023 Sep; 174:106112.

To gain insight into the research landscape of relevant reactor technologies, a literature study was conducted. **The core of the study was centered around two continuous reactor types (rotary kilns and screw reactors).** Roughly 130 research papers containing either of both technologies from recent years were screened and compared based on parameters like feedstocks types used (Figure 1), heat transfer or input capacity (Figure 2).

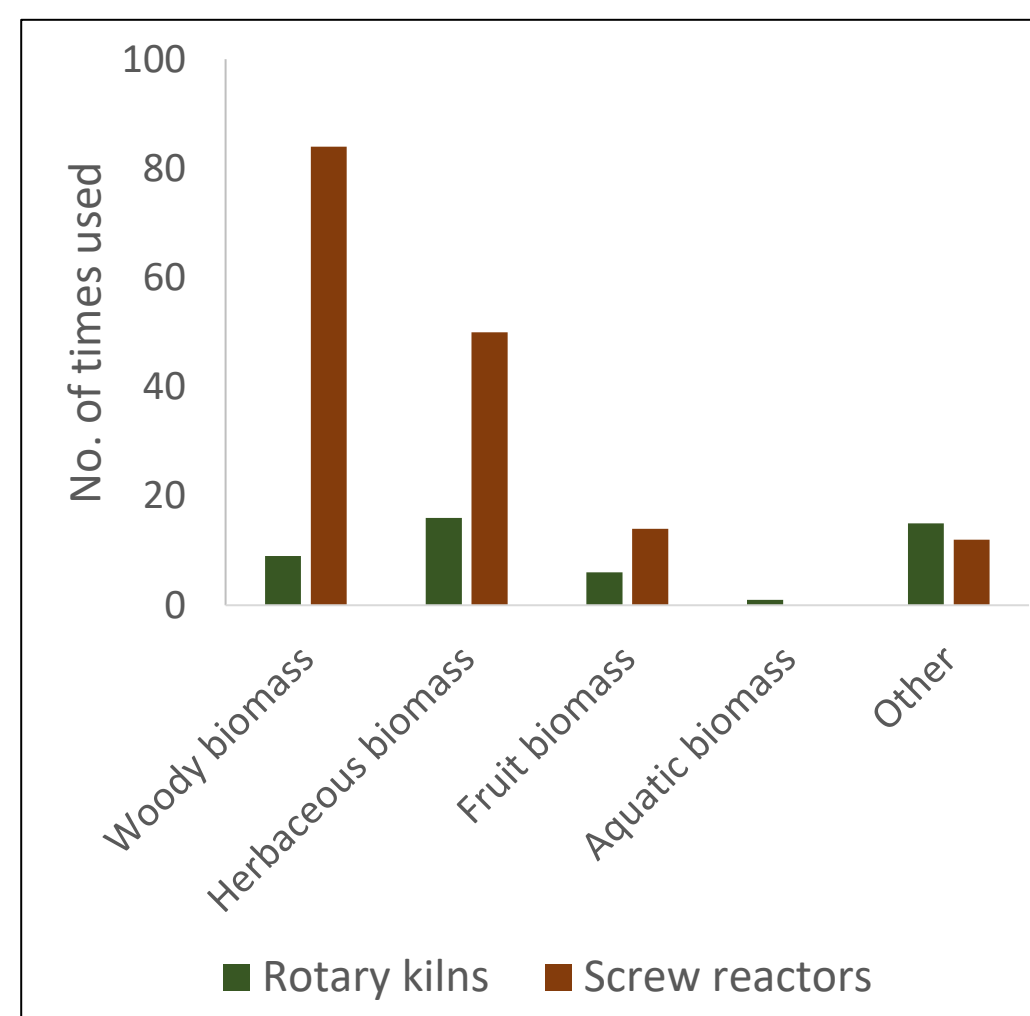


Figure 1: Feedstock types used in the reviewed literature, classified by DIN EN ISO 17225-1. The "Other" category covers all things not described by the norm (e.g., sewage sludge). If the same feedstock kind of different providers was used in one paper, only one instance was counted.

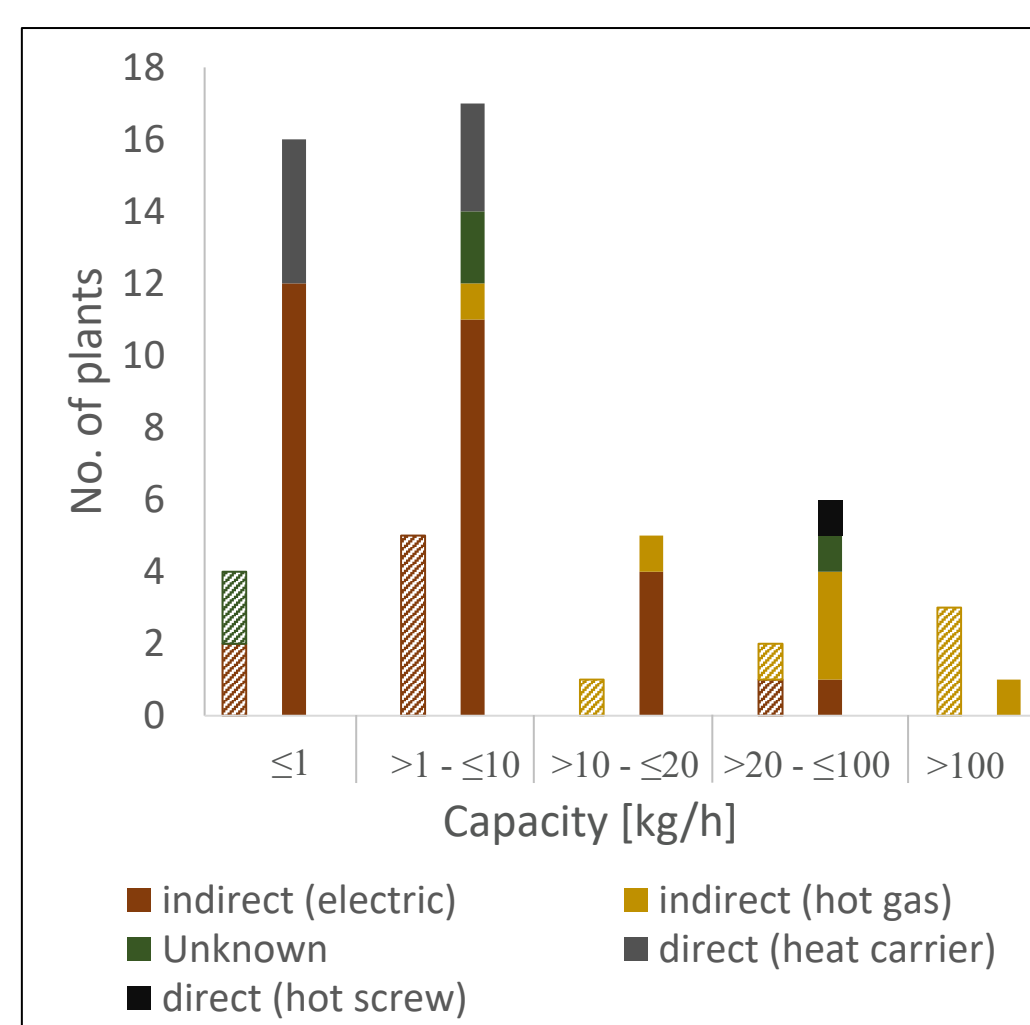


Figure 2: Input capacities and heat sources of the reviewed pyrolysis plants. The hatched columns represent rotary kilns, the filled columns represent screw reactors. The color code of the legend applies to both technologies.

Article 2: Moser K, Pfeifer C, Wopienka E, Voglar J, Prašnikar A, Likozar B, et al. **Exploring feedstock structural components as predictors for physico-chemical biochar properties.** Sci Rep. 2026 Jul 17.

Ten different feedstocks were pyrolyzed at two different temperatures in a batch type reactor technology. Feedstock and biochar samples were characterized thoroughly, and Pearson correlation were calculated to identify statistically significant correlations between biomass and biochar properties. Additionally, water solubility of major nutrients (extraction efficiency – EE) were correlated with feedstock and biochar properties. Highlights from the results are shown in Figure 3. Based on the results, certain biochar properties appear to be inherently predictable from feedstock data.

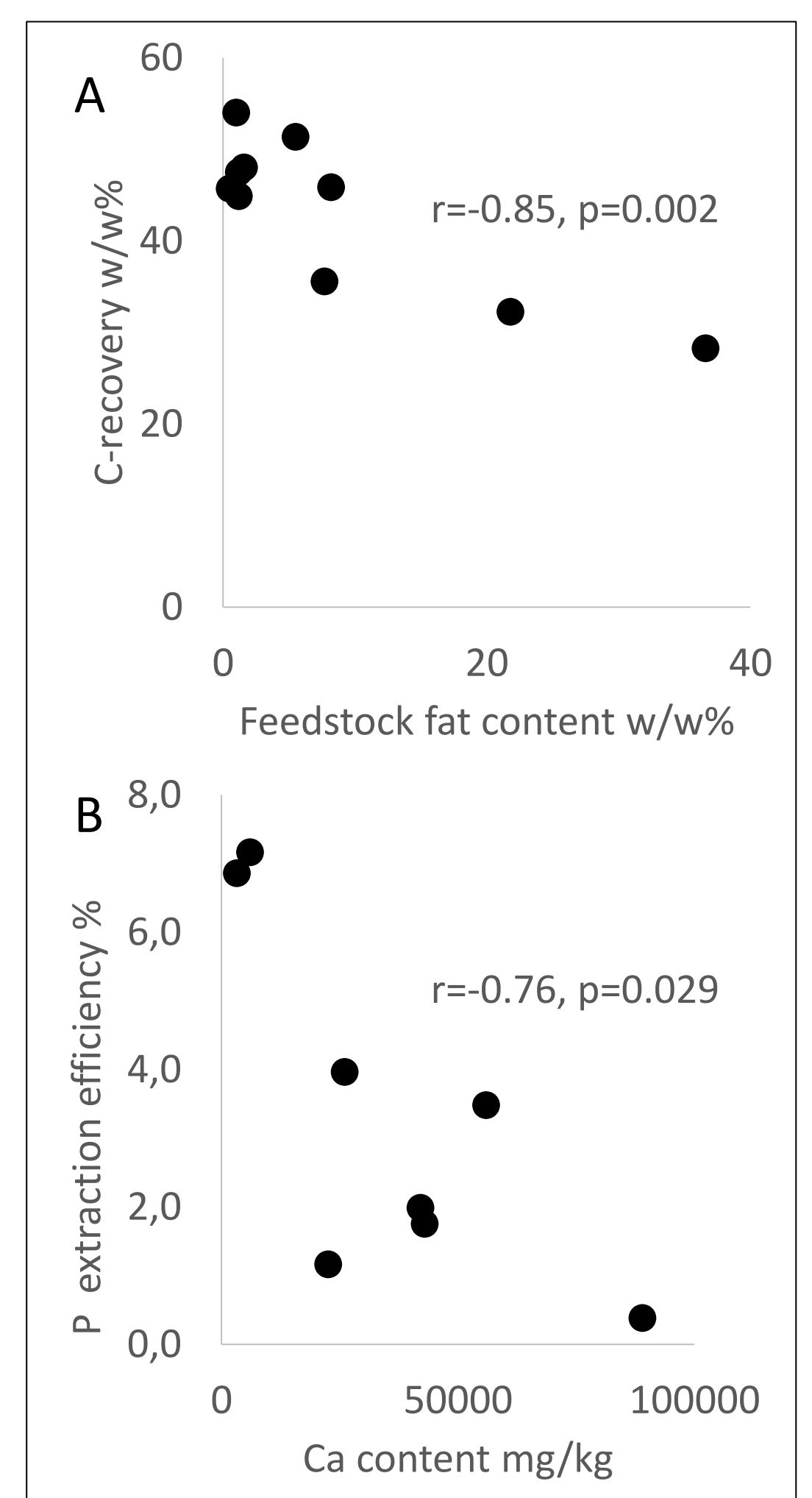


Figure 3: $T_{pyrolysis}=500^{\circ}\text{C}$ A) Correlation of C-recovery with feedstock fat content B) Correlation of P EE with biochar Ca content, excluding values <LOQ

Article 1



Article 2



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