

Characterization of P solubility and plant availability in various secondary raw materials with equilibrium- and sink-based extractions



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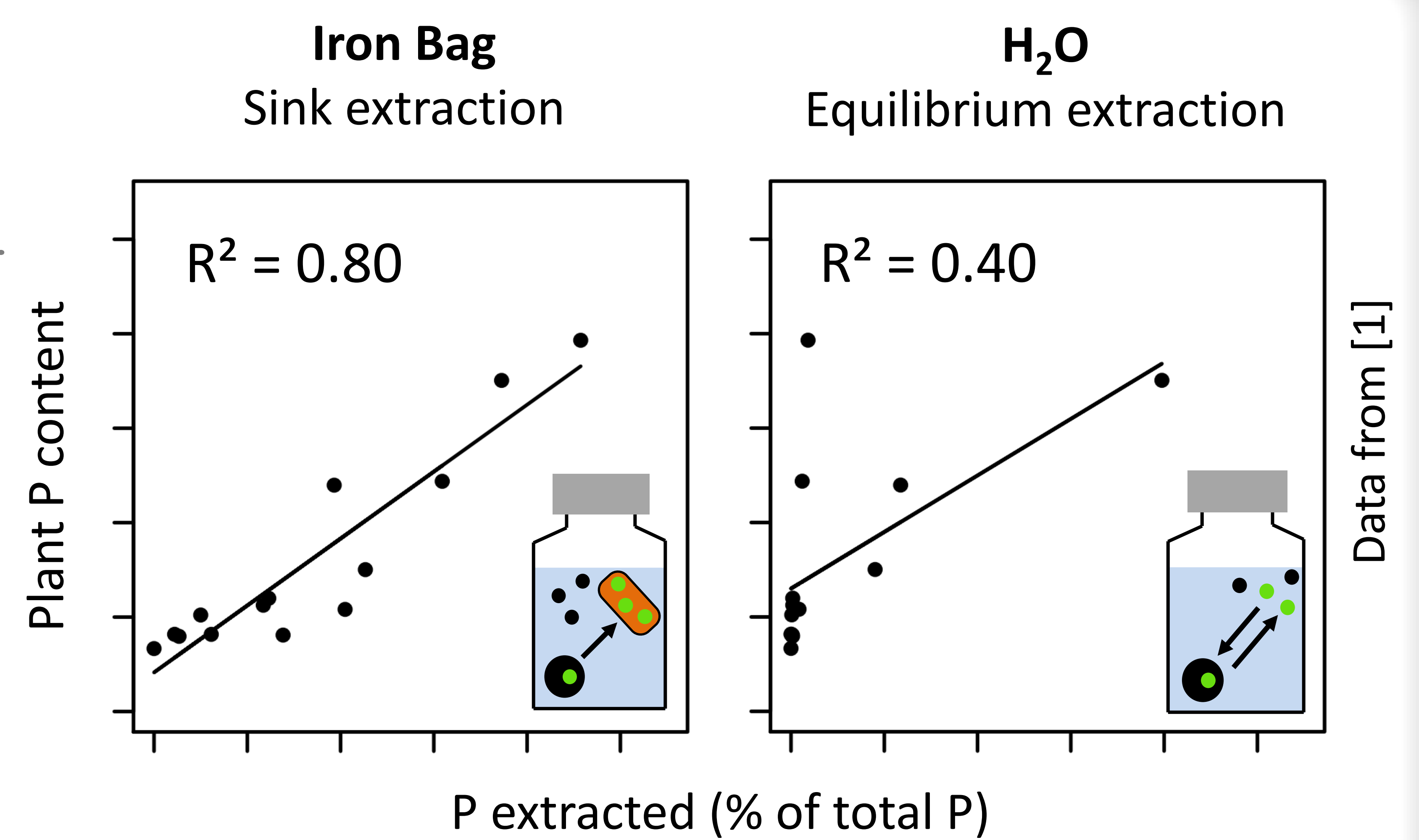
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INTRODUCTION

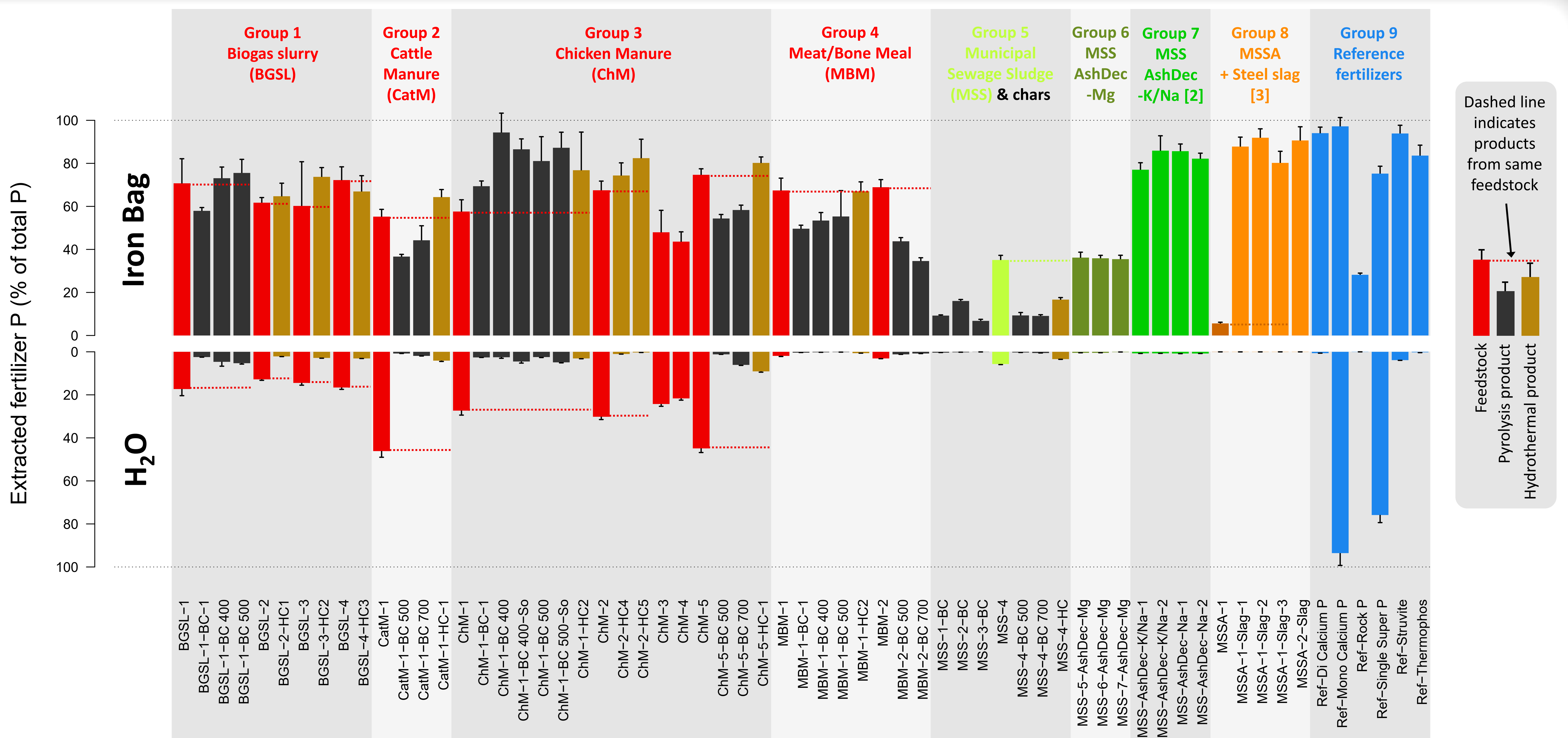
- **Recycling P fertilizers** from municipal sewage sludge (MSS), animal wastes, etc. are becoming increasingly relevant.
- **Infinite sink** ("Iron bag": up to 6-week extraction with ferrihydrite in dialysis membrane) better predicts plant P availability from chemically diverse fertilizers than H₂O or ligand-based extractions [1].
- **H₂O extraction** (1:100 w:v; 30 min) does not indicate plant availability, but it measures immediate solubility which may relate to environmental risk (runoff / leaching).

AIMS

- To **characterize a wide spectrum** of potential recycling P fertilizers with these two methods.
- To investigate the effect of **thermo-chemical processes** (pyrolysis, hydrothermal...) on P availability and solubility.



RESULTS



- Most potential P recycling fertilizers are **almost insoluble in H₂O**.
- **Pyrolysis** increases or decreases P availability (Iron Bag) from **organic feedstocks (Groups 1 - 4)** without a clear pattern, but it clearly reduces solubility in H₂O.
- P availability (Iron Bag) from **hydrothermal** processing of **organic feedstocks (Groups 1 - 4)** is similar to, or higher than the respective raw feedstock. But as for pyrolysis, solubility in H₂O is strongly reduced.
- P availability (Iron Bag) from **advanced treatments of MSS (Groups 7 & 8)** is ~90%, i.e. comparable to conventional fertilizers (Group 9).

CONCLUSIONS & OUTLOOK

- **Pyrolysis** and **hydrothermal** processes appear suitable for organic feedstocks (**Groups 1 - 4**):
 - 40 to 90 % of P is extractable by Iron Bag.
 - The lower H₂O-solubility of P after treatment can have positive environmental impact.
- **Municipal sewage sludge (MSS) and -ash (MSSA)** require more specific treatments to obtain plant available P (**Group 5 vs. Groups 7 & 8**) when chemical (Fe) P elimination is used in the wastewater treatment plant.
- A **pot experiment** in the greenhouse with different soils will help to sharpen these conclusions.

[1] Duboc et al. (2017) "Predicting phosphorus availability from chemically diverse conventional and recycling fertilizers", Sci. Total Environ. 599–600, pp. 1160–1170. [2] Herzel et al. (2016) "Sewage sludge ash – A promising secondary phosphorus source for fertilizer production", Sci. Total Environ. 542, Part B, pp. 1136–1143. [3] Bartsch et al. (2013) "Optimierte Ressourceneffizienz in der Konverterstahlerzeugung; Phosphoranreicherung und Aufschluss phosphorhaltiger mineralischer Reststoffe in flüssigen LD-Schlacken". Schlussbericht FKZ 033R004A-E

