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Phosphorus recovery from the end-products of the anaerobic digestion of municipal solid waste

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INTRODUCTION

In the last 50 years, the use of phosphorus (P) has quadruplicated.

In our world of limited resources, over-exploitation of known P reserves has flashed a warning signal:

how to ensure the continuous access to phosphorus and sustain human food production in a world where human population is growing fast?

(World's population in 2024: 8.2 billion people
Expected in 2050: almost 10 billion

OBJECTIVES

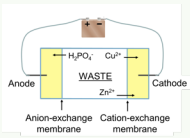
- Promote the circularity of PHOSPHORUS
- Explore the use of end-products of municipal solid waste as a secondary source of PHOSPHORUS
- Produce a high-quality fertilizer from waste

METHODS & RESULTS

Electrodialytic separation + **Gas permeable membrane**

An electric field separates phosphorus from contaminants (heavy metals)

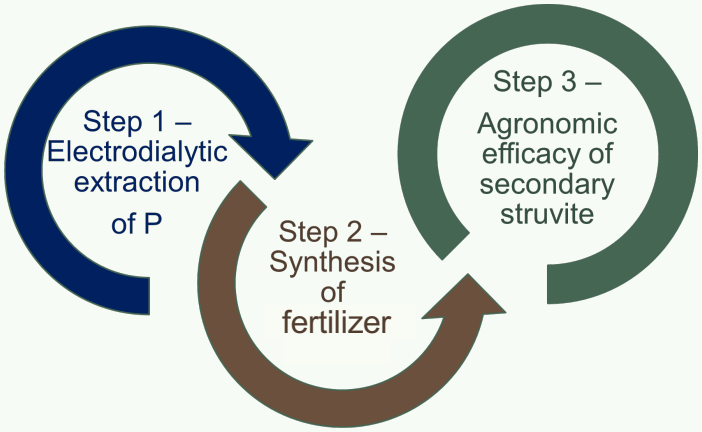
for extraction of ammonium (NH_4^+)



Extracted:

81% of the PHOSPHORUS
74% of the NITROGEN

...originally present in the waste



Chemical precipitation

STRUVITE
$MgNH_4PO_4{\cdot}6H_2O$

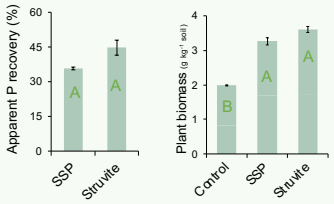
100% struvite SEM/EDS confirmed

Heavy-metal free
< conc. limits for Cd, Cr, Cu, Ni Pb, Zn

Green Synthesis
Alternative sources N (from waste) & Mg (from seawater)

Germination and pot-growth trials of RYE *(Secale cereale L.*

Secondary struvite is more effective in supplying available P than the traditional fertilizers SSP (single super phosphate)



PERSPECTIVES & CONCLUSIONS

The contaminant-free, secondary fertilizer, produced at lab scale widens the possibilities for the large-scale recycling of PHOSPHORUS and for the implementation of efficient strategies to close the nutrient cycles, towards a more sustainable resource management and enhanced food security.

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