Slow-Release Fertilizers Based on Dispersed Struvite in Thermoplastic Starch Matrix

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INTRODUCTION

- Struvite (St) is a green alternative for phosphorus (P) fertilization, recycled from urban wastewaters, manure, sewage, and other sources.
- St fast dissolution in acidic soils should be controlled to avoid runoff losses.
- St low water solubility can reduce environmental impacts, however, nutrient efficiency can be low when applied as granules.
- A strategy to control P dissolution while offering a granular material is to disperse ground St in a matrix, forming a composite.
- In the present work we propose to elucidate P release dynamics from sustainable fertilizer composites made of ground St embedded in a biodegradable thermoplastic starch (TPS) matrix.
- We aim to understand if TPS could improve St dissolution by particle dispersion effect, or whether TPS would restrict rapid P release by a barrier effect.

RESULTS

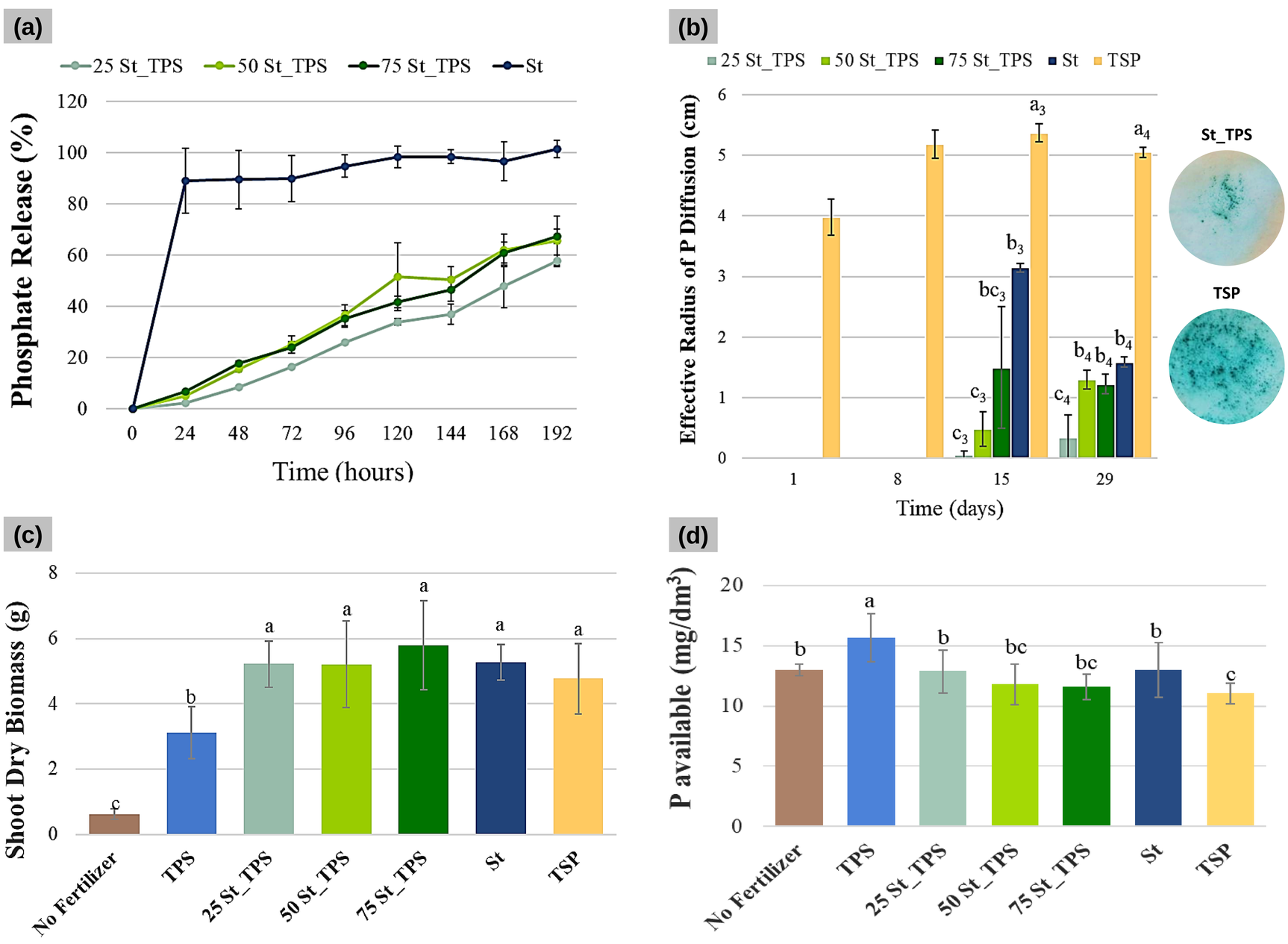

Figure 1. (a) P release trends in citric acid solution. St_TPS showed slow-release behavior, with TPS acting as a barrier to fast dissolution, indicating suitability for acidic environments; **(b)** Effective radius of P diffusion in sand over time. St dissolution was not improved by particle dispersion, however, TPS showed potential to prevent P leaching; **(c)** Dry biomass of maize shoots and **(d)** Available P in sand at the end of 42 days of maize cultivation; St_TPS achieved comparable maize growth to TSP, proving the steady-P-release from St_TPS was sufficient to fulfill plants' demands.

METHODS

- St_TPS composites were prepared with different rates of pulverized St: 25, 50, and 75 wt.%.
- P release and diffusion from the fertilizers was studied in citric acid solution and in a model substrate, i.e., a neutral sand with low P sorption capacity and no constituted fertility.
- The effect of P fertilization on maize (*Zea mays*) growth was studied in sand, under controlled greenhouse conditions.
- Triple Superphosphate (TSP) was used as a highly soluble and plant available reference.

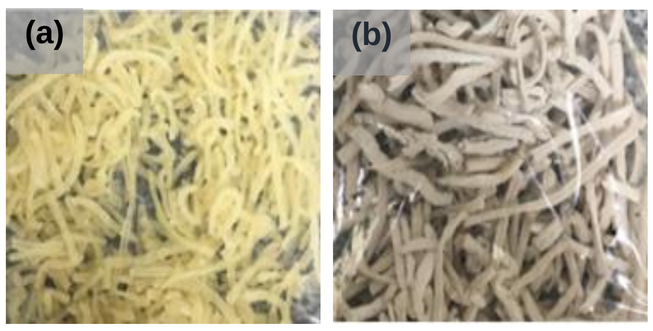

Figure 2. (a) Pure TPS and **(b)** 75 St_TPS composite, before grinding.

CONCLUSION

➢ St_TPS fertilizers:

- Provided adequate P nutrition to maize in highly permeable neutral sand.
- Prevented rapid P release.
- TPS biodegradation into organic acids could benefit St solubilization.

➢ Further studies should be conducted under field conditions in a sandy acidic soil.

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