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Abstract:

Recovering nutrients and reducing pollution through struvite precipitation from biomass waste

The benefits of plant nutrient recovery from biomass waste extend beyond agriculture to environmental conservation and resource management. By diverting organic waste from landfills and utilizing it for nutrient recovery, we can mitigate greenhouse gas emissions, reduce soil and water pollution, and conserve finite resources. An outstanding example of such a process is given by anaerobic digestion, able to convert organic wastes into biogas, a green energy source, and digestate, rich in plant nutrients. Digestate is normally separated into solid and liquid fractions. The solid can be used as organic fertilizer or soil improver, while the liquid is often disposed of. A smart strategy to avoid discharge of nutrients in water bodies, risking water pollution and eutrophication, is to precipitate ammonium and phosphate as struvite from the digestate liquid fraction. Struvite is a natural mineral with composition $NH_4PO_4Mg{\cdot}6H_2O$, which can be used as slow-release fertilizer to gradually supply nutrients to crop growth.

The aim of this study is to precipitate struvite from the digestate liquid fraction of two different biomass types: livestock waste and the organic fraction of municipal solid waste (OFMSW). When the digestate is separated into solid and liquid fraction, P tends to accumulate in the solid, while to be recovered as struvite it must be solubilized and transferred to the liquid part.

Different enzymes for organic matter degradation (cellulase, hemicellulase and protease) and organic phosphate hydrolysis (phosphatase and phytase) were tested, singly or combined with hydrodynamic cavitation. This last physical pretreatment strongly promoted P solubilization. The performance of this process was even improved when followed by the addition of the cited enzymes. High quality struvite was achieved from the digestate liquid fraction of the two biomass wastes, presenting high purity and relatively low carbon content. The slow-release capacity of the two products was evaluated and compared in different conditions.

Overall, these are promising results for the application of this process in circular systems for the recovery of N and P and the reduction of nutrient losses in the environment.

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