
SBPMat
B-MRS
SOCIEDADE BRASILEIRA
DE PESQUISA EM MATERIAIS
SALVADOR
XXIII B-MRS Meeting 2025
September 28th to October 2nd
BRICS
Brasil 2025

Composite Glass-Polymer Biofertilizers: A Sustainable Approach for Controlled Nutrient Release in Agriculture

Maria Eduarda Lemes dos Santos[1], Liane Miranda Carvalho[1], Danilo Manzani[1]

[1]São Carlos Institute of Chemistry (IQSC), University of São Paulo (USP), São Carlos, SP, Brazil

e-mail: eduardalemes@usp.br

The growing demand for food necessitates more efficient and sustainable agricultural practices. Conventional fertilizers, due to their high solubility, release nutrients rapidly, requiring frequent applications and contributing to environmental issues such as nutrient leaching and eutrophication of water bodies. In this context, glass fertilizers (GFs) emerge as a promising alternative, incorporating essential nutrients such as phosphorus (P_2O_5) and silicon (SiO_2) while enabling controlled solubility through glass network modulation. Additionally, combining GFs with biodegradable polymer matrices, such as alginate, can optimize nutrient release, minimize losses, and enhance plant absorption. In this study, a composite biofertilizer based on phophosilicate GF was developed and encapsulated in alginate spheres. The fertilizers were synthesized via melt-quenching and incorporated into the polymer matrix through ionotropic gelation. The materials were characterized using FTIR, Raman spectroscopy, TGA, DSC, and SEM to assess their thermal stability, chemical structure, and morphology. Nutrient release was evaluated through dissolution tests in two media—aqueous and buffered (pH 4.7) – by monitoring mass loss, pH variation, ion release, and structural changes post-exposure. The results indicate that nutrient release occurs in a controlled manner, with a more pronounced effect in acidic conditions. Alginate encapsulation yielded homogeneous materials with controlled size and improved GF stability against ambient moisture. Optimization of preparation parameters, particularly the GF-to-alginate ratio, resulted in uniform and stable spheres. These findings highlight the significant potential of composite biofertilizers for agricultural applications, as they enable tunable nutrient release in soil through the integration of GFs with biodegradable polymers.

Acknowledgements
FAPESP, CNPq, CAPES, PUB/USP (2024-4727)

References
[1] Atei, P. et al. Environmental Technology & Innovation p. 102722 (2022).

[2]Araújo, B. A. et al. Research, Society and Development p. e49010918248-e49010918248 (2021).