

Innovative valorization of bovine bones from the meat industry in Paraguay: mineral matrices for soil sustainability

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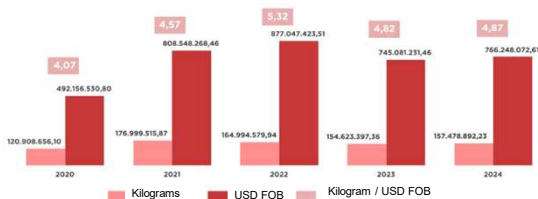
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INTRODUCTION & AIM

Paraguay ranks among the top ten global exporters of beef, generating significant quantities of bovine bone by-products from its thriving meat industry.

In line with circular economy principles, the development of mineral matrices derived from bovine bones offers an innovative and sustainable alternative to conventional soil amendments.

This work presents the conceptual design and initial development of such matrices, aimed at enhancing soil fertility while reducing reliance on synthetic fertilizers.



Paraguayan beef exportation from 2020 to 2024. Source: National Service of Quality and Animal Health of Paraguay (SENACSA) (2024)

METHOD

Bovine bones obtained from industrial meat processing plants in Paraguay were calcinated at controlled temperatures (400°C, 500 °C, 600°C, 700 °C, and 800 °C) for one and two hours to produce mineral-rich powders.

These powders, primarily composed of hydroxyapatite and secondary phases, were subjected to TGA, FTIR, XRD, and particle size analysis to determine the best calcination conditions to produce the base material for biodegradable soil matrices.

The process includes grinding, sieving, and compaction with additives, targeting matrices with suitable mechanical properties and nutrient release profiles for agricultural applications.

Acknowledgments:

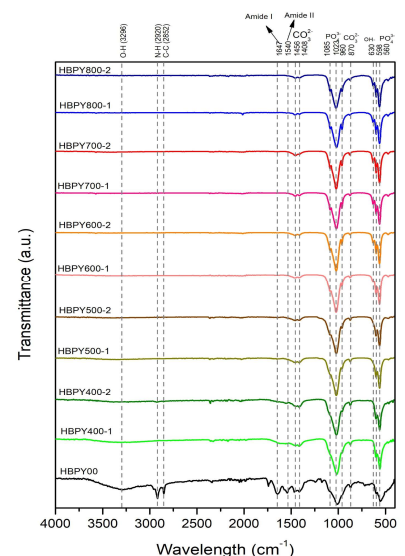
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RESULTS & DISCUSSION



The different calcination times and temperatures determine the physicochemical properties of the base powders, thus the functionality of the produced matrices.

The designed process demonstrates a feasible pathway for transforming bovine bone waste into valuable soil amendment materials, supporting nutrient cycling within food production systems. The proposed valorization strategy provides a promising solution for integrating agroindustrial by-products into sustainable soil management.



FTIR spectrum of powder from Bovine bone from raw (HBPY00) to 800°C (HBPY800-2)

CONCLUSION

Beyond closing nutrient loops and reducing waste, this innovation offers a novel perspective on hydroxyapatite applications. Unlike conventional biomedical uses, this approach explores its potential as a mineral matrix for soil sustainability, opening new avenues for circular solutions in agriculture. Further work will focus on matrix characterization and soil functionality tests.