ADVANCING LIVESTOCK WASTE VALORIZATION AS A HIGH-VALUE ORGANOMINERAL STRUVITE FERTILIZER: A PILOT-SCALE STUDY

N.I. Kallikazarou[1], I.A. Fotidis[2], L. Koutsokeras[3], D.A. Kokkinidou[3], C. Michael[4], E. Constantinide[5], G. Constantinides[3], A.S. Anayiotos[3], G. Botsaris[4], and M.G. Antoniou[1,*]

[1]Department of Chemical Engineering, Cyprus University of Technology, P.C 3036, Limassol, Cyprus
[2]Department of Environment, Ionian University, P.C. 29100 Zakynthos, Greece
[3]Department of Mechanical Engineering and Materials Science and Engineering, Cyprus University of Technology, P.C. 3036, Limassol, Cyprus
[4]Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, P.C 3036, Limassol, Cyprus
[5]Department of Environment, Ministry of Agriculture, Rural Development and Environment, P.C 2025, Strovolos, Nicosia, Cyprus
* *maria.antoniou@cut.ac.cy*

ABSTRACT

The Mediterranean region faces significant challenges concerning food security and safety. A major cause of this problem is the disposal of inadequately treated livestock waste in soil and water resources with adverse environmental implications[1,2]. Currently, the most common manure management practice is solid-liquid separation, while a small percentage of these waste is anaerobically digested (6.4% in EU 27[3]). Therefore, in order to alleviate this problem, technologies and processes that turn hazardous waste into valuable and profitable resources, are urgently needed. CUT participated in the Interreg MED project RE-LIVE WASTE, where the existing struvite crystallization reactor (SCR) from a previously built pilot that anaerobically treated livestock waste, was upgraded and re-operated to convert livestock waste into high-value commercial organo-mineral fertilizers (struvite). A series of pilot-scale struvite crystallization experiments was first conducted utilizing ultra-filtration (UF) permeate as starting material. Pig slurry or mixed livestock were anaerobically treated, with the digestate effluent filtered through filter bags and UF ceramic membranes prior to struvite precipitation in the 250-L SCR. The produced struvite precipitates were analysed for their quality characteristics by X-Ray Diffraction (XRD), Scanning Electron Microscopy coupled with Energy Dispersive X-ray analysis (SEM-EDX), and X-Ray Fluorescence (XRF), spectroscopic techniques. Several analytical techniques for fertilizers were used for the determination of parameters such as polycyclic aromatic hydrocarbons (PAHs), and hexavalent chromium (Cr^{6+}). Struvite precipitates from UF permeate mixed waste and pig slurry had high purity, more than 90% w/w, based on XRD analysis using Reference Intensity Ratio method. Typical struvite structures such as orthorhombic were observed in SEM-EDX. The precipitates complied with the regulatory requirements for pathogens, carcinogens (PAHs, PCBs, and Cr^{6+}), and heavy metals (XRF) (Regulation (EU) 2019/1009). Overall, results from our pilot-scale process unveiled that nutrient recovery from recalcitrant livestock waste is feasible, producing a high-value solid organo-mineral fertilizer.

KEYWORDS: pilot-scale, struvite, ultra-filtration, livestock, organo-mineral fertilizer

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