

RE-LIVE WASTE project: Advancing pilot-scale nutrient recovery from livestock wastewater by struvite crystallization

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Introduction

Global Phosphorus-P availability, mined as phosphate rocks is expected to deplete within the next 50–100 years¹. With global food security and zero hunger being part of the UN Sustainable Development Goals for 2030 and the EU2020 strategy aiming for sustainable growth, alternatives to phosphorus mining are in need. The Mediterranean region, is characterized by intensive cattle and pig livestock farming, producing large amounts of waste and generating greenhouse gases emissions and nitrate leaching in groundwater². Recovery of nutrients from livestock waste maybe a sustainable solution into mitigating their negative impact into the environment while producing marketable and profitable products (biofertilizers).

References

- Cordell D. et al, *Global Environmental Change Journal*, 19, (2009), 292.
- Casasús I. et al., *EAAP Scientific Series*, 131, (2012), 276.

Project's Main Objective

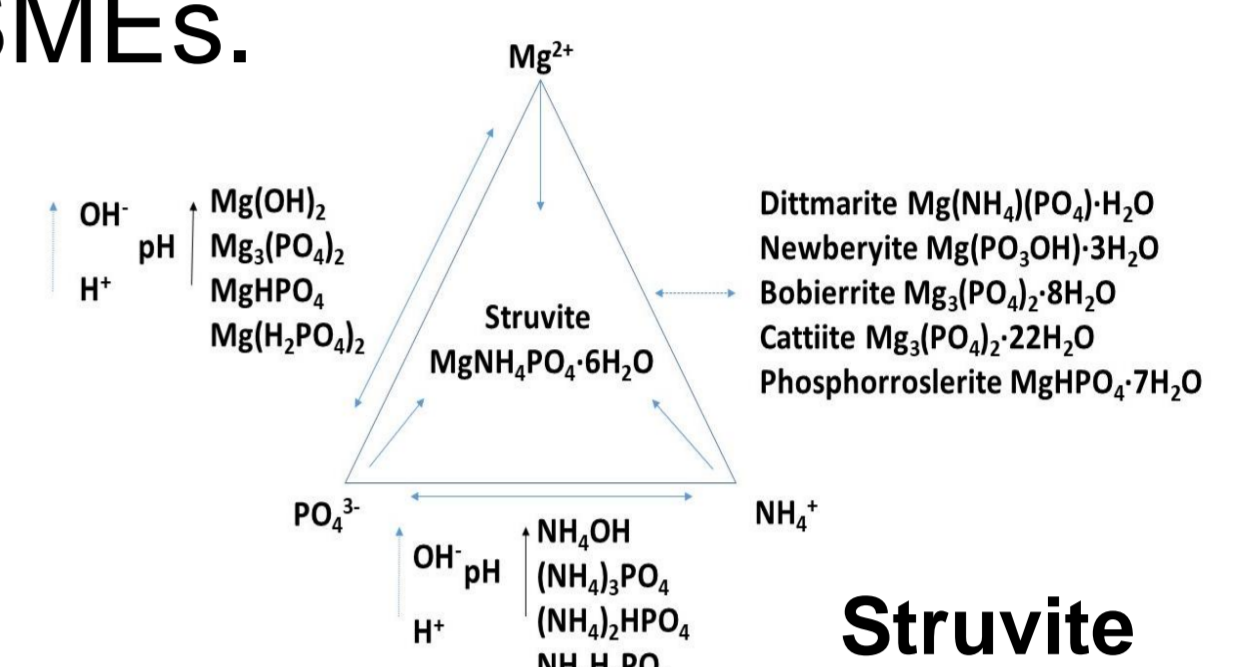
The Interreg MED project RE-LIVE WASTE aims to achieve efficient livestock waste management through the installation of four pilot plants in the Mediterranean region that transform livestock waste into organic, high-value, commercial fertilizer (struvite). The project is comprised by 13 partners from 4 countries (Italy, Spain, the Federation of Bosnia and Herzegovina and Cyprus) including universities, research centers, competent authorities and SMEs.



Treated livestock waste



Struvite Produced at the CUT Pilot

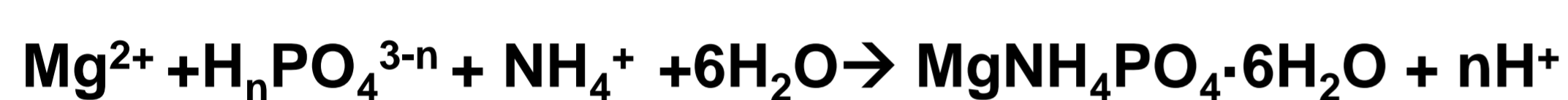


Re-print by Tansel B. et al., *Chemosphere*, 194, (2018), 504

Project's outcomes

Struvite Precipitation

Struvite crystallization is a very promising technology, in which removal and recovery total ammonia nitrogen and orthophosphates occur according to the following reaction³:



Struvite precipitation from wastewater is influenced by a number of parameters such as pH reaction, molar ratio, interfering ions in the feed, reaction time, types of chemicals added, types of the reactor used and temperature. From the above, pH and molar ratios of magnesium : ammonium: phosphate are the main factors driving struvite precipitation⁴⁻⁶ and based on our results the optimum are 8,7 and 1.2-1,5:1:1, respectively.

Optimal Molar Ratio



References

- Huang H. et al., *Bioresource Technology*, 172, (2014), 253
- Darwish M. et al., *Separation & Purification Reviews*, 45, (2016), 261.
- Latifian M. et al., *Environmental Technology*, 33, (2012), 2691.
- Perera P.W. A. et al., *Biomedical and Environmental Sciences*, 20, (2007), 343

Pilot plant in Cyprus



Struvite Crystallization Reactor (SCR) upgrade



LIFE LIVE WASTE SCR 50 L

Mg(OH)₂ added
NH₄⁺:PO₄³⁻:Mg²⁺
1:0,3:1
Quantity: 150 g/day

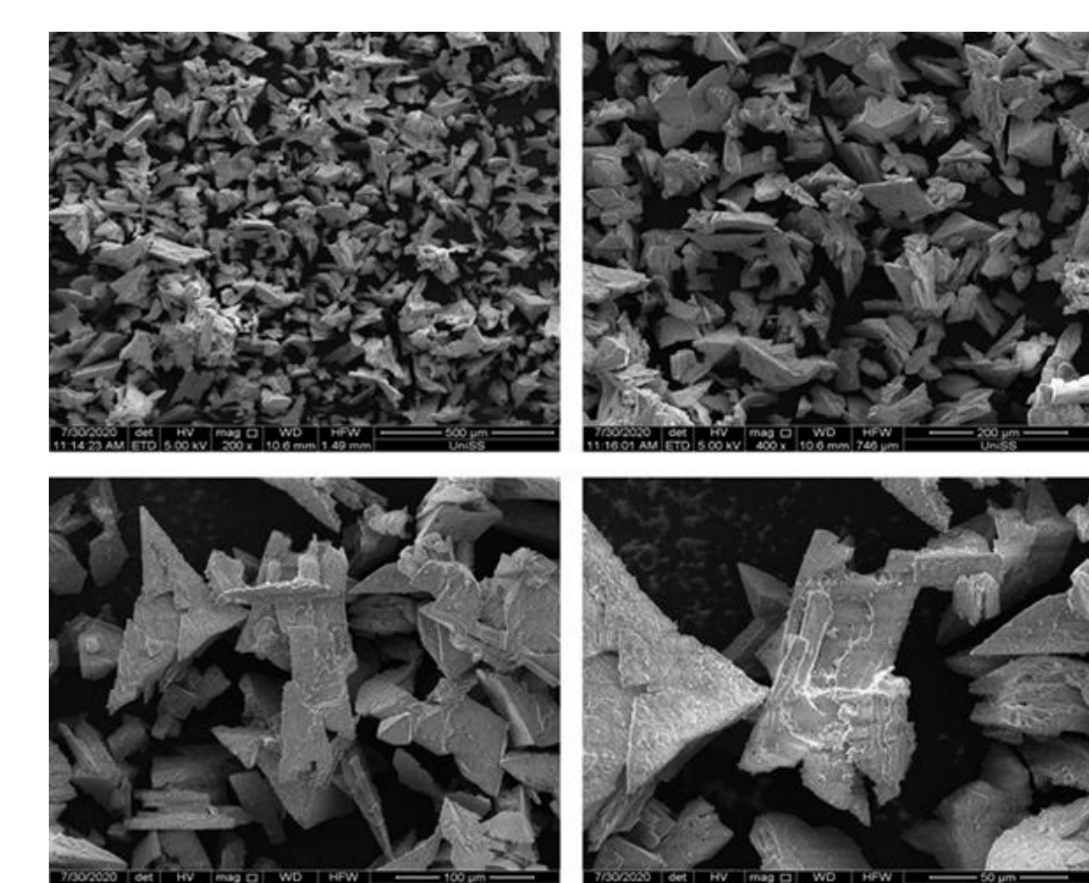


RE-LIVE WASTE SCR 250L

Mg(OH)₂ and H₃PO₄ added
NH₄⁺:PO₄³⁻:Mg²⁺
1:1:1,2-1,5
Quantity: 4,5 kg/250L

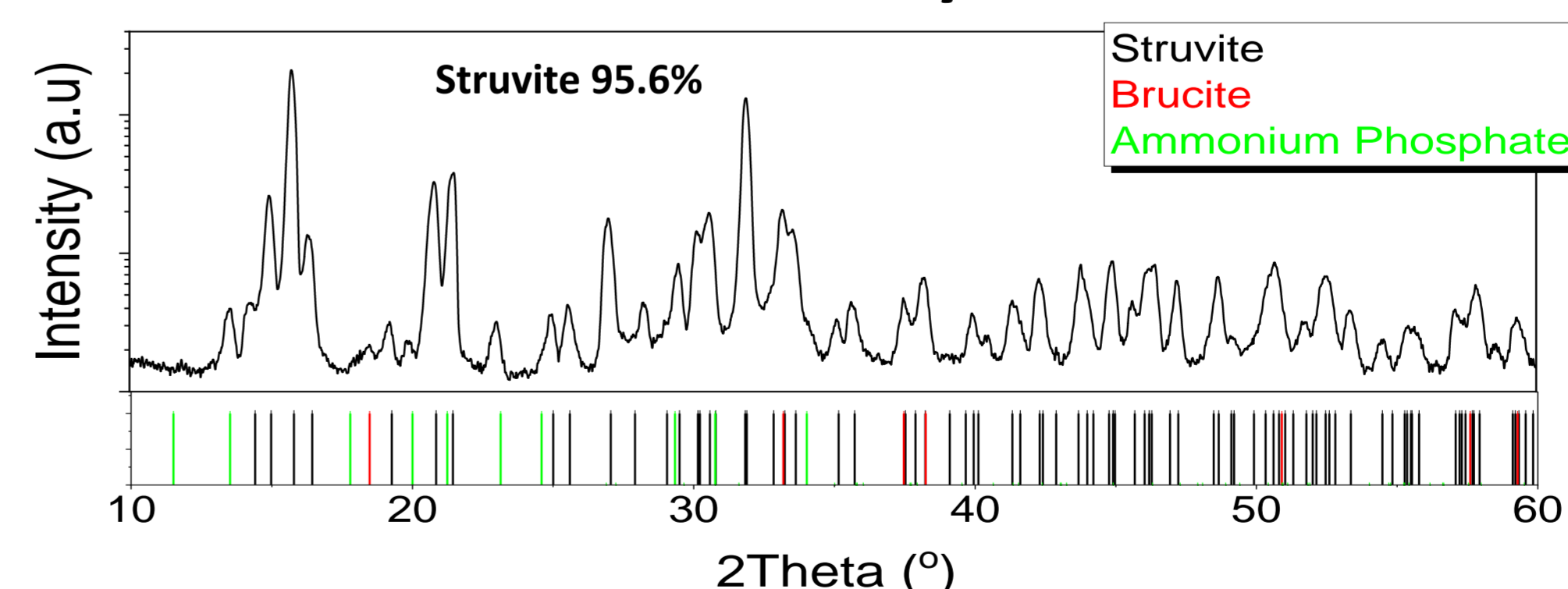
In the case study of Cyprus pig slurry or mixed influent (comprised of 50% pig slurry, 25% cheese whey, 25% chicken manure and rarely fruit organic waste and barley) was anaerobically treated with the digestate effluent filtered through filter bags and ultra-filtration (UF) prior to struvite precipitation. Struvite enriched precipitate (SEP) was analyzed for its chemical characteristics, metal, carcinogens, and pathogens content, X-ray diffraction analysis (XRD) to assess the purity and composition of the struvite produced, and scanning electron microscope SEM analysis to assess shape and size of the crystals.

SEM Analysis



Parameters	Result (%)
Magnesium (Mg ²⁺)	10.68
Phosphorus (P-PO ₄ ³⁻)	4.55
Ammonium (NH ₄ ⁺)	5.1
Calcium (Ca ²⁺)	1.5

XRD Analysis



The struvite produced in the CUT pilot contained no pathogens, no heavy metals, and no carcinogens and was of high purity.

Pilot plants of Spain, Bosnia-Herzegovina and Italy

Spain: Centrifuged pig slurry from ALIA and pig manure from CITA-IVIA research center was treated at the CITA-IVIA research center for the production of SEP.

Bosnia-Herzegovina: Cow manure was separated (solid-liquid separation) and the liquid fraction will be treated (deammonification) for the production of SEP.

Italy (Sardinia): AD liquid digestate was treated for the production of SEP from the Arboreas' Cooperative AD plant treating cattle manure and corn silage.

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