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NUTRIENT RECOVERY FROM WASTEWATER AND SEWAGE SLUDGE

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SPOKE, WP, TASK

SPOKE 8: ***New models of circular economy in agriculture through waste valorization and recycling***
WP 8.3: ***Nutrient and organic matter recovery from wastes to reduce the use of agrochemicals and closing waste cycle***
TASK 8.3.1: Nutrient recovery from wastes to produce mineral fertilisers and promoting water recovery

INTRODUCTION & AIM OF THE WORK

- In this work, **reclaimed water reuse** and **nutrient recovery from sewage sludge** (mainly phosphorus) have been investigated for agricultural purpose, in the view of the recent circular economy plans [1] and European Regulation [2].
- Secondary and tertiary effluents collected from a municipal wastewater treatment plant (WWTP) in Emilia-Romagna were used to water **basil plants** grown in laboratory on a commercial potting soil supplemented with conventional chemical fertilizers, under precision lighting, from the seedling to the flowering stages.
- A thorough chemical and microbiological **characterization of effluents** from the WWTP is being carried out in the view of agricultural reuse.
- A sewage sludge from the same WWTP has been treated for **P recovery** [3] by **enzyme extraction** as a P-rich liquid product with the aim of exploiting it, with fully characterized wastewater, in agronomical tests of fertigation [4] to basil plants, to investigate the possibility of decreasing the need for conventional chemical fertilizers in crop-like conditions.

MATERIALS & METHODS

- **AGRONOMICAL TESTS:** ENEA precision ventilated lamps (lab system with controlled ventilation and lighting) for basil growth (Fig.1)
- **ENZYMES:** Acid phosphatase (P-AC), Alkaline phosphatase (P-ALK), Cellulase (CELL), deionized water (H_2O) as control.
- **P RECOVERY FROM SEWAGE SLUDGE**: Enzyme solution: 1unit/100mL; Sludge/Enzyme: 1/5 w_{fm}/v; Incubation, 37°C, 1h, 120 min^{-1}; Centrifugation: 9.000 rpm, 20min; Filtration: Whatman® no.42 paper filters.

Figure 1: Enea precision ventilated lamp

- **WASTEWATER CHARACTERIZATION**: Online and real-time monitoring of chemical (pH, COD, N-NO_3^-, N-NH_4^+, P-PO_4^{3-}) and microbiological (*Escherichia coli*) parameters of WWTP effluents, through specific instruments and probes.

RESULTS & NEXT STEPS

- **AGRONOMICAL TESTS:** Basil plants watered with effluents from WWTP showed similar growth and development of the control ones (tap water).
- **P RECOVERY FROM SEWAGE SLUDGE**: Enzymatic hydrolysis through cellulase and acid phosphatase allowed the extraction of 260 mg/L of soluble P corresponding to more than 5.000 mg_P/kg_{dm}, that is a concentration about 70 times higher than the one obtainable in deionized water (Fig. 2).
- **WASTEWATER CHARACTERIZATION**: The calibration line of the instrument for online and real-time determination of bacterial load in wastewater describes the relationship between microbial activity (pmol/min) and concentration (CFU/100 mL) for *Escherichia coli* (Fig. 3).

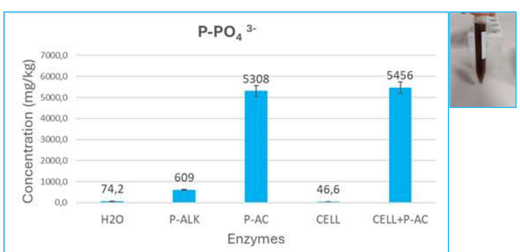

Figure 2: P solubilization after hydrolysis with different enzymes

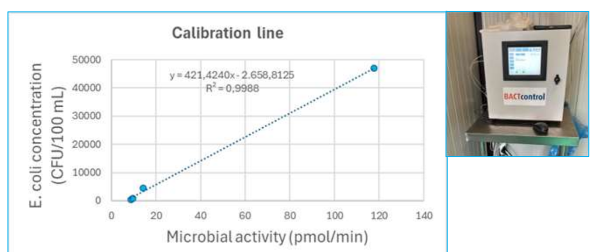

Figure 3: Calibration line for *Escherichia coli* of the instrument for bacterial load monitoring

- ***NEXT STEPS****: Agronomical tests on basil plants by using liquid hydrolisate as P source instead of chemical fertilizers.*

REFERENCES

[1] COM (2020) 98 Final. A new Circular Economy Action Plan for a cleaner and more competitive Europe.

[2] Regulation EU 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse.

[3] Pant H.K., Warman P.R. (2000) Enzymatic hydrolysis of soil organic phosphorous by immobilized phosphatases. Biology and Fertility of Soils (2000). 30:306-311

[4] Chojnacka K. et al. (2020) A transition from conventional irrigation to fertigation with reclaimed wastewater: prospects and challenges. Renewable and Sustainable Energy Reviews 130 (2020):109959

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