LIFE-BioLubridge: Biolubricants from urban sewage sludge

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Introduction

In Europe, wastewater treatment processes produce around 10 million tonnes per year of sludge. Such a value is going to increase up to 13 million tonnes according to the Wastewater Directive (91/271/EEC). The management of this waste in an economically, environmentally, and socially acceptable way represents one of the major issues to be faced by the modern society.

Sludge is mainly produced by wastewater treatment plants (WWTPs) after a sequence of operations based on physical, chemical, and biological treatments of raw sewage, which end with a dewatering step, operated through press-filtration or centrifugation.

Nearly half of the management costs in charge of WWTPs come from sludge disposal, which actually is a wet solid (water content 80-84%). For this reason, huge efforts have been dedicated by research teams to reduce the humidity into the final sludge, which would result in final sludge reduction of the weight to be disposed of. To this scope, several polyelectrolytes are presently added before final dewatering which have a negative impact for the environment.

Consequently, there is a need to develop alternative sludge management methods which respond to a sustainable minimization and address the resource recovery concept in agreement with the "circular economy" strategy. One promising way to address this issue is to save the chemical potential of organic components in raw sewage sludge through processes that isolate useful compounds having a value.

Very recently a detailed chemical characterization was conducted on the lipid phase of sewage sludge: free fatty acids, estolides and 10-hydroxystearic acid were also found therein in significant amounts (di Bitonto *et al* 2021, 2020).

All these specific compounds might represent valuable bioderived and biodegradable alternatives to fossil lubricants (or precursor). Nowadays, the annual worldwide demand for lubricants is assessed to be around 45 Mt and in Europe, according to European Commission sources, 5.7 Mt year^{-1} lubricant is used.

Presently the main feedstock used to produce bio-lubricants are triglycerides and oils derived from dedicated culture (palm oil, rape seeds oil, sunflower oils, etc.), as synthetic ethyl hexyl esters, resulting in the use of consistent amounts of natural resources.

Project objectives

LIFE-BioLubridge project will propose and demonstrate an innovative and solvent-free technology (Pastore *et al* 2018) to obtain lubricants from sewage sludge, lowering the environmental impact of these products and in line with principles of Circular Economy.

Figure 1. Innovative technology proposed for the complete valorization of sewage sludge.

LIFE-BioLubridge has the following main objectives:

1. Optimization and demonstration of an innovative solvent-free technology capable of recovering lipids from sewage sludge to be converted into valuable products;
2. Conversion of extracted lipids into valuable components for the production of biolubricants, which are ready for application in automotive, metal working and other fields;
3. Improvement of the dewaterability of residual sewage sludge and evaluation of its biofertilizing capability;
4. Shortening of the overall treatment of sludge (up to 20 times faster).

LIFE-BioLubridge project will create a new value chain based on a circular economy concept, through the connection of two unmatched worlds: the treatment of sludge and the sustainable production of biolubricants.

AQP will be directly involved into the project with VITONE ECO company which will design and manufacture tools and systems to be adopted for treatment of wastewater and oil extraction. In addition, industry partners with experience in converting raw lipids into valuable esters, namely CERATEC, and FIOCHEM which will guarantee the direct test on the market of metalworking fluids. All the steps will be monitored and studied by CNR-IRSA which will actively contribute to every decision.

The application of the BioLubridge technology will be facilitated by the interest of every single company in their specific area of interest. Such a group represents the initial step towards the creation of a new virtuous value chain that will last after the end of the project and will be replicated in other contexts the EU.

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