

# Upcycling Polyphenols from Industrial Olive Oil Waste

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## Abstract

Olive oil production plays a vital role in the economy of Mediterranean countries, being one of the most important industrial activities. However, it generates a significant waste product called alperujo. Alperujo is composed of a mixture of water, solid parts of the olive, and fatty residues. In Spain, the largest producer of olive oil, the production of olive oil was ca. 1.2 million tons in the 2019/2020 campaign, followed by Italy and Greece with productions of 0.34 and 0.3 million tons respectively. This means a production of alperujo of more than 7 million tons in these three countries. Due to its large annual production and its polluting properties, the disposal of alperujo poses significant legal and environmental challenges in Mediterranean countries, since uncontrolled dumping can cause soil deterioration in nutrient content, pH, conductivity and water retention capacity, odor problems and pathogen transmission (Garcia-Ortiz, 2016). Moreover, due to its recalcitrant nature, the presence of polyphenols in wastewater hinders the application of traditional biological treatments (Muñoz-Palazon et al., 2023). To address this issue, a novel approach is proposed in this study, which involves utilising alperujo as a raw material for extracting valuable polyphenols. It is worth noting that alperujo is a waste material and therefore, it is not used in food applications. Polyphenols are highly sought-after products in the food, nutraceutical, pharmaceutical, and cosmetic industries. The process entails using water, an environmentally friendly solvent, to extract polyphenols at low temperature. Experiments were performed to test the impact of water:alperujo ratio, extraction temperature, and time. The total polyphenolic content (TPC) was measured using Folin-Ciocalteu analysis and HPLC. The highest TPC observed at the laboratory scale was 354 mg GAE/kg alperujo at room temperature after 10 minutes of extraction with an alperujo water ratio of 1:4. Furthermore, a pilot plant has been designed to process 5 tons of alperujo per day and produce 7000 kilograms of polyphenols per day with a final concentration of 1900 mg GAE/L. The pilot plant consists of two main steps: (i) the extraction unit and (ii) the concentration of polyphenols using a series of membranes. This design is based on a previous pilot plant at a smaller scale

which was able to obtain 9 g of polyphenols/kg residue from a winery industry. The dephenolised alperujo produced during this process will be treated in an anaerobic digester for biogas generation. The overall process developed in this study demonstrates both technical and economic viability as a sustainable and zero-waste solution for managing olive oil waste, thus, contributing to the development of the circular economy within the olive oil sector.

**Keywords:** polyphenols, alperujo, circular economy, green solvents

### References

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