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OPTIMIZING THE VALORIZATION OF OLIVE MILL BY-PRODUCTS FOR THE PRODUCTION OF BIOGAS, ELECTRICITY AND HEAT

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SPOKE, WP AND TASK

SPOKE 8: Circular economy in agriculture through waste valorization and recycling

WP: Agroenergy production from wastes to reduce energy dependence

TASK 8.2.1: Biotechnologies to produce electricity, heat and advanced fuel from wastes

INTRODUCTION AND AIM

INTRODUCTION

The olive oil supply chain generates a large number of **by-products** often treated as waste, with high environmental and economic costs (Roselló-Soto et al., 2015). It is possible to produce **biogas, thermal energy, and electricity** from by-products and co-products obtained in the olive mill through different approaches, such as biochemical, thermochemical, and electrochemical methods.

AIM

Optimize the production of **biogas** from olive mill by-products and co-products by experimenting with the addition of **olive leaves** to **olive mill wastewater** (OMWW) for anaerobic digestion; **optimize** the **biogas** production process based on the **numerical simulations**; **improve** the production of **thermal energy** from **olive pits** with a new technology to clean them of pulp and olive skin residues; perform experiments to produce **electrical energy** by electrochemical conversion of **olive leaves** and **pomace** in abiotic 3D-printed biofuel cells.

MATERIALS AND METHODS

BIOGAS

Samples. OMWW and a mixture of OMWW and 4% of leaves (OMWWL) were stored at -20°C until use.
Characterization. Total solids (TS) and volatile solids (VS): gravimetrically measured; pH: pH meter; lipid content: Soxhlet extraction.
Analyses. Biomethane Potential (BMP) analysis: Methan tube® digester.
Biogas composition: µGC.

BIOGAS-CFD

The simulation of a digester of different sizes is performed in the context of a Computantional Fluid Dynamics (CFD) modelling method, which accounts for the fluid rheology and the agitation conditions (Maluta et al., 2024). The outcome of the investigation is twofold: the identification of the change of scale criterion and the possibility to gain insight into the fluid-dynamic behaviour of the digester.

HEAT

A prototype for the separation of impurities (olive pulp and skin) from olive pits was tested in the lab and installed in an olive mill.
Characterization of the olive pits: total solids (TS): gravimetrically measured; lipid content: Soxhlet extraction.

ELECTRICITY

Samples. Glucose at variable concentration (biomass model) and olive leaves 20% w/w, both pretreated with alkali.
Characterization. Open circuit voltage (OCV), short current intensity (ISC), output power density (P) per covered surface area.
Apparatus (Setti and Maggiore 2022). Three sequential units: alkalinization (generation of biofuel from waste biomass), electrochemical (biofuel conversion into electrical energy), neutralizer (potential production of biofertilizer from exhausted biofuel).

RESULTS

BIOGAS

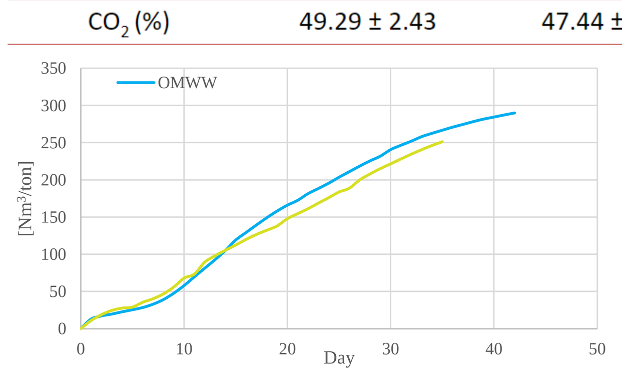
Characterization

Sample	TS (% w/w)	VS (% w/w)	Lipidic content (% w/w)	pH
OMWW	20.56 ± 0.15	16.58 ± 0.67	0.75 ± 0.03	5.2
OMWWL	18.31 ± 0.12	14.17 ± 1.02	1.36 ± 0.03	5.2

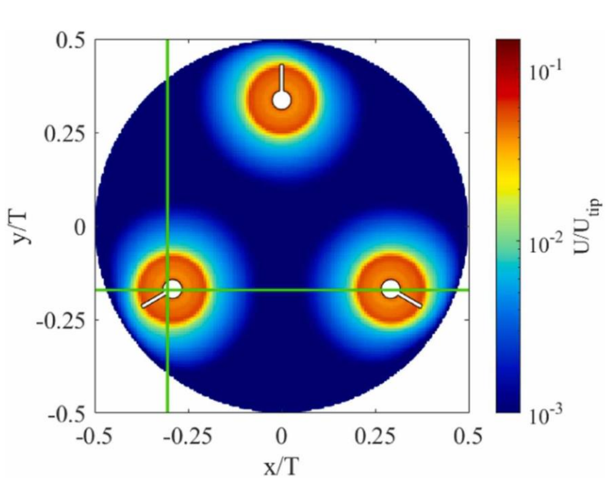
BMP

OMWW and OMWWL did not show significant differences with a t-student test (p>0.05) in biogas production, nor in gas composition.

Content	OMWW	OMWWL
CH_4 (%)	50.71 ± 2.43	52.60 ± 0.44
CO_2 (%)	49.29 ± 2.43	47.44 ± 0.44



BIOGAS-CFD



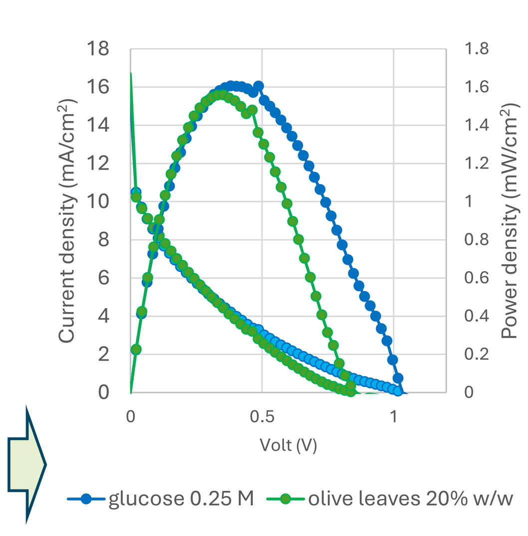
Example of the non-dimensional velocity in an horizontal cross-section of a digester. CFD allows to identify dead zones and critical shear stress conditions.

HEAT

Characterization analyses of the pits collected from different Italian olive oil mills and respective samples without impurities are underway.

ELECTRICITY

Feedstock	OVC (V)	ISC (A)	P max (mW/cm²)	Peak Voltage (V)	operation mode
glucose 0.25 M	1.36	0.32	2.00	0.35	flux (anolyte)
glucose 0.5 M	1.37	0.36	3.20	0.55	flux (anolyte)
glucose 0.75 M	1.40	0.39	3.50	0.55	flux (anolyte)
glucose 1 M	1.35	0.50	3.80	0.50	flux (anolyte)
glucose 0.25 M	**1.37**	**0.21**	**1.60**	**0.35**	**static**
olive leaves 20% w/w	**1.15**	**0.20**	**1.55**	**0.38**	**static**



- Olive leaves give fuel cell performance comparable to glucose 0.25 M in static condition (preliminary tests).
- After alkali treatment on olive leaves, the solid waste mass decreased by 42 ± 6% in weight (dry matter).

REFERENCES

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