Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

Mediterranean Cooperation in the Treatment and Valorisation of Olive Mill Wastewater (OMW)

MEDOLICO

Deliverable 3

Activity 6: Pilot demonstrations

- **Activity 6.1 Design and setting up of pilot plants**
- **Activity 6.2 Training of personnel**
- **Activity 6.3 Pilot testing, 1st milling campaign**

EXECUTIVE SUMMARY

Activity 6: Pilot demonstrations

Activity 6.1 Design and setting up of pilot plants

Activity 6.2 Training of personnel

Activity 6.3 Pilot testing, 1st milling campaign

The deliverable illustrates the scale-up and performance demonstration of three pilot plants previously tested at bench scale for olive mill wastewater (OMW) treatment and the preliminary greenhouse phytotoxicity tests. Also, a pilot study is described for OMW treatment which provides a concentrate rich in phenols that could subsequently be isolated for valorisation studies.

As stated in previous Deliverable 2, all activities run straightforwardly by all partners involved in these tasks. It is worthily to emphasize the difficulties related with the transportation and delivery of treated OMW samples between the different partners.

The scale-up of pilot plants, the training activities, and the main results achieved by each partner are presented in detail in the individual tasks (6.1, 6.2 and 6.3) of Deliverable 3.

However, each task is summarised as follows:

Activity 6.1

This activity describes the specifications of OMW treatment pilot plants from the responsibility of each partner in MEDOLICO project as follows:

LNEG, Portugal – JACTO.MBR reactor with coupled UF membranes.
UCY, Cyprus – Advanced Solar-Fenton photocatalytic oxidation technology with coagulation/flocculation pre-treatment.
UNIGE, Italy – Integrated membrane process of reverse osmosis (RO) with microfiltration (MF): MF/RO technology.

JUST, Jordan– JET-loop Pro reactor.

BGU, Israel – Microfiltration and nanofiltration membranes. Polyphenols extraction and purification from RO concentrates.

For OMW treatment, one pilot (110L) was working during the first and second milling campaign at LNEG, and two pilots (100 and 1000L) were constructed to work at JUST, for the second milling campaign. Only the 100L reactor is ready to work at JUST, despite the efforts that have been made in order to overcome the shortcomings in the construction of the equipment. All the experiments at pilot scale for solar-Fenton photocatalytic oxidation and integrated MF/RO technologies are running as planned in UCY and UNIGE, respectively. BGU improved an UF process / NF membranes application to separate salts from polyphenols. BGU also optimized the extraction and purification of polyphenols from RO concentrates.

Activity 6.2

LNEG provided technical and scientific support to JUST partners in order to setting-up the procedures of biological OMW treatment using the jet-loop technology. The training of personnel from JUST working with JACTO.MBR reactor occurred in LNEG installations during one week of October 2013. This support has been continued and information exchanged via e-mail when necessary. A document was created by LNEG, the “Laboratory Operating Procedure: JACTO.MBR reactor”, to support the training activity of JUST partners.

Activity 6.3

This activity describes the experiments developed at pilot scale for each OMW treatment technology.

UCY explored the efficiency of solar Fenton process combined with previous coagulation/flocculation pre-treatment at a pilot-scale reactor in removing the different organic carbon fractions present in OMW. The effect of different additive concentration to

improve coagulation/flocculation process was studied. Also several parameters were evaluated to optimize the solar Fenton reaction at pilot scale. A COD removal higher than 87% was achieved and the polyphenolic fraction, which is responsible for the biorecalcitrant and/or toxic properties of OMW, was eliminated. The feasibility of the oxidation process was assessed in terms of toxicity removal using a set of bio- and phyto-assay. LNEG assess the technical feasibility of the aerobic biological treatment of OMW at a pilot-scale JACTO reactor with ultrafiltration membrane system. The influence of the main operational parameter hydraulic retention time and of the COD:N:P ratio on the removal efficiency of organic matter and polyphenols was studied. Under continuous feeding, the best efficiency of the OMW treatment process was 72% and 77% respectively for COD and total phenols removal, achieved at tested HRT 9d. UNIGE improved operative process conditions for MF/RO treatment technology. RO process resulted in very high conductivity and COD retention: >98 and 94 – 96%, respectively, and a total phenols removal (retention 100%, total phenols not detectable in RO permeate). So RO concentrate is a valuable, polyphenol rich by-product of the process. For polyphenols recovery and purification tests, UNIGE sent to BGU a sample produced in RO process rich in polyphenols liquid phase. BGU presented nanofiltration pilot scale experiments running OMW permeate after UF.

For irrigation tests, UCY, LNEG, UNIGE and BGU sent to JUST about 100L of treated OMW samples, each. In Jordan, greenhouse phytotoxicity tests were performed by JUST, using corn as a forage crop and preliminary results were shown in Deliverable 3. The experiments on the pilot plant Jet-loop Pro, in Jordan, started at the beginning of campaign 2013/2014 and experiments are in progress. All the JUST activity connected to the use of the pilot plant as well as the greenhouse experiments will be reported in the Deliverable 4 or Deliverable 5.

Optimization of operating conditions and procedures is in development for all pilot plants and experiments will occur in the next milling campaign. Results and conclusions will be reported in Deliverable 4.

ABBREVIATIONS

AOPs	*Advanced Oxidation Processes*
BOD_5	*Biochemical Oxygen Demand*
CFU	*Colony Forming Units*
COD	*Chemical Oxygen Demand*
DO	*Dissolved oxygen*
FLC	*FLOCAN 23 polyelectrolyte*
HRT	*Hydraulic Retention Time*
JLR	*Jet-loop type reactor*
MF	*Microfiltration*
MLSS	*Mixed liquor suspended solids*
NA	*Nutrient Agar*
NF	*Nanofiltration*
OMW	*Olive Mill Wastewater*
OLR	*Organic Loading Rate*
PDA	*Potato Dextrose Agar*
PET	*Polyethylene terephtalate*
PVDF	*Polyvinylidene fluoride*
RO	*Reverse Osmosis*
TMP	*Transmembrane pressure*
Total-N	*Total Nitrogen*
TP	*Total Phenolic Compounds*
Total-P	*Total Phosphorus*
TS	*Total Solids*
TSS	*Total Suspended Solids*
UF	*Ultrafiltration*
VCR	*Volume Concentration Rate*
VSS	*Volatile Suspended Solids*
YMA	*Yeast Malt Agar*

Contributions by:

Nireas – International Water Research Center, University of Cyprus

Irene Michael

Angeliki Panagi

Despo Fatta-Kassinos

BGU - Ben-Gurion University of the Negev

Zeev Wiesman

Jack Gilron

Galina Neumark

Zhana Abramovich

UNIGE – Università degli Studi di Genova

Gustavo Capannelli

Anna Jezowska

Aldo Bottino

Antonio Comite

Raffaella Firpo

Camilla Costa

JUST – Jordan University of Science and Technology

Munir Rusan

LNEG – The National Laboratory of Energy and Geology

Ana Eusébio

Ana Anselmo

Belina Ribeiro

Céu Penedo

Lina Baeta-Hall

Ivone Torrado