

## OLEICO + SUSTAINABILITY IN THE OLIVE MILL WASTE MANAGEMENT

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### Abstract

Olive oil production generates olive mill wastes estimated at 2.5 million tonnes. More than 80% of olive mill wastes consist in water. Olive mill wastewater (OMW) has environmental impacts due to its high organic load and contents in phenols, lipids and organic acids. The project Oleico +, supported by the European Program LIFE, brought together 4 Institutions from 4 European Member States to seek and select a set of environmental friendly technologies for the remediation or valorization of olive mill wastes, and to raise the awareness of olive oil stakeholders for an environmental sustainable olive mill waste management. The OLEICO + project selected eight technologies to manage olive mill wastes that may be applied to different olive mill systems and amounts of waste generated. This selection was performed with a point to grid classification of technologies sustainability and status. To access eco-sustainability several parameters were accounted, including carbon dioxide emissions, landscape impacts and bead smells. Eleven technologies were selected out of 28 inventoried. Specifically five of these technologies deal with OMW and its detoxification, and four of them produce reusable water for irrigation. Other three technologies are focused in the energetic and or agronomic valorization of olive mill wastes. Some of these technologies present positive net income values, a many of them do not require specialized workforce, but the small dimension of olive mills make the management of olive mill wastes a challenge for the industry.

Key words: Olive mill wastewater, eco-sustainability, olive mill wastewaters management

### INTRODUCTION

The olive oil industry represents one of the most important economic agro-food sectors in the Mediterranean countries where more than 98% of the world's olive oil estimated at over 2.5 million metric tons per year is produced. The largest olive oil producers are Spain with 36%, Italy with 24%, and Greece with 17%, of the world's total olive oil production. Portugal, with a production of one order of magnitude lower than the three leading countries, France and Cyprus contribute to the 75% olive oil production achieved in the European Union (McNamara *et al.*, 2008; Lopes *e tal.*, 2009).

The olive oil extraction generates large amounts of liquid effluents (4–8 kg of waste waters per kilogram of olive oil). The nature of the effluents varies with the extraction systems but all have significant environmental impacts due to high concentration of phenols, lipids and organic loads.

The OMW contains a majority of the water-soluble chemical species present in the olive fruit, a very high organic load chemical oxygen demand, (COD) typically ranges from 50–150  $\text{gl}^{-1}$ , about two orders of magnitude higher than municipal wastewater and has an acidic pH (4–6). Phenolic compounds that are present in olive stones and pulp tend to be more soluble in the water phase than oil, resulting in concentrations ranging from 0.5–25.0  $\text{gl}^{-1}$  (McNamara *et al.*, 2008). These phenolic compounds are the main determinants of antimicrobial and phytotoxic olive-mill wastes actions and are responsible for its characteristic black colour (Cabrera *et al.*, 1996).

On the other hand, these residues are likely to be considered valuable resources, due to their large quantities of organic matter, the wide range of recyclable nutrients and energy content.

The Oleico + project, involves four institutions from four European Union Member States: ISRIM – Istituto Superior di Ricerca e Formazione sui Materiali Speciali per le Tecnologia Avanzate (Italy), AEMO – Asociacion Española de Municipios del Olivo (Spain), LNEG – Laboratorio Nacional de Energia e Geologia (Portugal) and TU–Crete Technical University of Crete (Greece)

The Oleico + project aims at i) raising awareness among the olive industry operators of the environmental concern caused by the careless disposal of the olive waste; ii) collect, evaluate and disseminate information about the best technologies available to deal with olive mill waste in an economically viable and environmental sustainable way.

## METHODS

Oleico+ covers four European Union Member States: Greece, Italy, Spain and Portugal. The institutions involved in each country made a broad inventory of all technologies developed to deal with olive mill wastes, as well as the respective national legislative and territorial frameworks.

Technologies were evaluated with a cost-benefit analysis comprising: Patent and publications generated by the technology, type of technology (input residues), environment impact (balance of water, energy, and other products, production of waste and air emissions), status of technology (existing plants), and economic data (associated costs and net income value). The ranking of technologies was performed by weighting each of the parameters above.

Of the initial 28 technologies inventoried, 11 were selected for dissemination in the awareness raising campaign in each country (table1). For each of the selected technologies a SWOT analysis was performed considering the legal framework of each country.

## RESULTS AND DISCUSSION

The eco-sustainability performance of the different technologies was heavily affected by energy consumption and its consequent carbon dioxide emissions. The occurrence of bad smells and landscape impacts of facilities did also affect this parameter. Only one technology achieved the three smiles classification the Phytoremediation (Santori *et al.*, 2006), because of its benign impact on landscape

after construction and low energy consumption. But this technology requires large implantation areas depending on the amount of OMW to treat.

The biocombus technology (Claro et al, 2007), has a positive energy balance, but has also a heavy impact on landscape, and requires energy for transportation of other residues to mix with OMW.

The Co-digestion system (Berardino, 2007) applies to waste water treatment plants and has a positive energy balance.

*Table 1. Selected technologies of olive mill wastewaters*

Technology	Reference	Process	Output	Eco-sustainability
Electro-coagulation device	(Boye et al, 2005)	Electro-chemical	Clarified water	☺
Evaporation-Hydrolysis-Oxidation		Thermal	Clarified water Bio fuel	☺☺
Phytoremediation	(Santori et al, 2006)	Biological	Word biomasa	☺☺☺
Aerobic biological treatment	(Tziotzios et al, 2007)	Biological	Clarified water	☺
TIRSAV	(Altieri, 2007)	Physical	Mixed compound for other industries	☺☺
Co-digestion system applied to waste water treatment plants	(Berardino, 2007)	Biological	Clarified water and biogas	☺☺
Biocombus	(Claro et al, 2007)	Physical	Industrial pellets	☺☺
Composting (3 technologies)		Physical and biological	Organic fertilizers	☺☺

Composting technologies have heavy landscape impacts, and involve emissions of bad smells in the beginning of the processes. On the other hand all inputs are integrally treated.

## CONCLUSIONS

So far the project demonstrated that the treatment of olive mill waste waters is a subject of great to the scientific community and the industry that keep working on new and existing technologies to deal with this issue. The awareness raising campaign for the management of olive mill wasting will be occurring simultaneously in the four countries, with workshops, seminars, printed material and internet dissemination. Feed back from these campaigns will provide more results for this project. Although some of these technologies have positives net present values, they all require some amount of investment not easily available for small olive mills.

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