

Treatment and Reutilization of Effluents: One Mediterranean Project

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The problematic of effluent treatment from olive oil industry as been the subject of an European Commission funded project (INCO-MED programme): "Mediterranean Usage of Biotechnological Treated effluent Water". The potential that effluent offers to increase the availability of water, in mediterranean regions, was the final goal of the project, co-ordinated by INETI with partners from EU and MPC. In the project different systems for the treatment of this effluent had been studied: reactors systems (Intensive type) based on the jet-loop principle (JACTO) and an anaerobic UASB hybrid type reactor technology; lagoons (extensive type) for municipal wastewater treatment were also applied. The aerobic JACTO system demonstrated high unit capacity for biological conversion and operation at different loadings, allowing the removal of the pollutant organic load and the toxicity associated with this effluent. The use of this type of reactor for pre-treatment of OOWW prior to disposal on a lagoon system was tested at FSS (Morocco). Use of fungi as a pre-treatment was tested by UNITUS (Italy), EBC (Turkey) and CBS (Tunisia). In this way the effluent could be "improved" as demonstrated in the case of anaerobic digestion and biogas production (CBS). Effluent improvement and enrichment with phosphate was also tested by UNITUS. Analytical monitoring methodologies were developed at IA (Spain) and treated effluents were tested for a number of agricultural applications in different countries. The different alternatives studied will be analysed and compared taking account of technological and socio-economical criteria in relation with the project objectives.

Introduction

Among the most difficult effluent to treat and that bigger problem presents it is the case of black waters associated to the industry of the oil.

The main areas of olive oil production are in Spain (2.4 million ha), followed by Italy (1.4 million ha), Greece (1 million ha) and Portugal (0.5 million ha).

The EU currently dominates the global market, producing over 70 per cent of the world's olive oil. Tunisia, Turkey and Syria are the only other producers of significance, accounting for over 20 per cent of world production.

This type of effluent have high organic loading (COB₅ between 50 – 100 kg/m³ and COD 20-200 kg/m³), presence of organic compounds which are hard to biodegrade such as long-chain fatty acids and phenolic compounds.

Another characteristic of this effluent is seasonal operation and big dispersion in territory.

Many methods, both chemical-physical and biological, have been tried to reduce the organic load of this effluent. These methods have in common the fact that they are relatively expensive, they are not applicable in all situations, and most of them are not able to withstand fluctuation in the hydraulic and pollution load (J.C.Duarte *et al.* 2004).

Medusa Water is a Communitarian project INCO-MED "Medusa Water – Mediterranean usage of biotechnological treated effluent water

The coordination of this project is from responsibility of INETI.

There are seven partners in this project: INETI, Lisboa, Portugal; University Cadi Ayad, Marrakech, University EGE, Ismir, Turquia; Biotecnology Center of Sfax, Tunísia, University of Tuscia, Viterbo, Itália; University of Granada – Instituto del Água, Granada, Espanha e TECNIA, Lda., Torres Vedras, Portugal.

With this project was intended to increase, in mediterranean regions, the water availability, for on activities to agriculture, through reutilization of waters from treated effluents proceeding from agro-industries and wastewater plant.

For such the black waters had been submitted to specific pre-treatments, being able to be treated by conventional or mixing biological ways.

Of followed the gotten results of each partner will be presented.

Aerobic Treatment

Portugal

In the aim of Project Medusa water was studied JACTO system for treated this type of effluents based on the principle of "Jet-Loop".

The principal advantages of bioreactor JACTO are: Efficient oxygen transfer and high turbulent mixing, High efficiency for biological conversion, Operation at different loadings (Petruccioli *et al.*, 2002).

The results obtained were 90 % COD removal and 80 % Phenol removal after 220 days of treatment.

Also they had been carried through bio tests to evaluate the toxicity of the effluent not treated and treated having itself verified that the olive oil wastewaters were very toxic and after treatment had passed to not toxic..

SAMPLE	Ecotoxicity Tests	
	Microtox	Thamnotox kit F
Olive oil wastewater	Very toxic for bacteria <i>Vibrio fischeri</i>	Toxic for crustaceous <i>Thamnocephalus platyurus</i>
Treated Effluent (JACTO)	Not very Toxic for bacteria <i>Vibrio fischeri</i>	Not very Toxic for crustaceous <i>Thamnocephalus platyurus</i>

Table 1 – ResultS of Ecotoxicity Tests

It's concluded that the system offers to an alternative technique for treatment of the olive oil wastewaters, allowing the removal of the pollutant organic load and the toxicity associated with the effluent, it allows using without problem for ground and cultures, of the water treated for irrigation.

Italy

The main research activity carried out by the laboratory of General and Applied Microbiology, Department of Agrobiologic e Agrochemical, University of Tuscia involved the application of fungal organisms or their enzymes for the treatment of OOWW.

The fungal organisms used in this project were *Aspergillus niger* and *Panus tigrinus*.

Treated and untreated OOWW were spread on agricultural soil both in greenhouse and on open field. Several crops such as wheat, maize, chick pea and sunflower where grown on the treated soils. Controls were carried out using water and normal P fertilizers.

The soil spread with the microbial treated OOWW resulted in better crop yield.

A. niger is rather efficient in P solubilisation and COD removal but its performance is quite scarce in phenol removal.

Unfortunately, the majority of OOWW contain high amount of phenols therefore to forecast a treatment with *A. niger* a pre-treatment to reduce the phenol content of the effluent is absolutely necessary.

Moroco

In Department of Biology, of University Cadi Ayyad in Marrakech was studied the functioning of a system of domestic residual water treatment pre-treated by natural lagoons was followed during four years. The gotten results are very satisfactory and show that the system allows getting an effluent one with very good a sanitary quality.

Therefore it was decided to test the capacities of the lagoons to previously receive effluent treat for the system JACTO that was carried to Marrakech with mixture from effluent urban and olive oil wastewater treated waters.

The preliminary results suggest that the addition of olive oil wastewater to the lagoons does not influence the performance of the system; this continues to function as if it was fed exclusively by effluent urban.

The extrapolation of the gotten results suggests that a system of lagoons conceived for the treatment of 10 000 habitant-equivalent allows to treat, annually, 1000 m³ of olive oil wastewater previously treated with a reactor to the type "Jet-Loop".

Anaerobic Treatment

Tunisia

The objective of this project is the development of technology for the removal of the recalcitrant contaminants of olive mill wastewaters (OMW), involving anaerobic digestion and allowing water recovery and reuse for agricultural purposes.

Among different biological and physico-chemical pre-treatment methods a flexible technology able to reduce the toxicity level of OMW and improving the anaerobic digestion process.

It was introduced a step of pre-treatment of olive oil wastewater with fungo basidiomiceta *P.chyso sporium*, for reduction of toxicity of the effluent before its introduction in the metanogenic anaerobic reactor.

As result its being tested anaerobic digester pre-industrial scale with volume of 25 m³.

The anaerobic reactor attain a production of 150 m³ de biogas com 70% de methane, 285 kwh de electricity e 600 Kwh thermic energy.

The treated effluents in region of Sfax with this technology will produced 136 MW energy/year, 75 000 ton of bio-fertilizer and 200 000 m³ water for re-use.

Conclusion

The developed systems offer to interesting alternatives for treatment and effluent valorization of normally considered a very harmful one for the environment.

The solutions to adopt will vary in each case depending on the conditions and local necessities. The project demonstrated the viability technique of the biotechnological alternatives.

Its economic viability will have to be assured conveniently by the reutilization of effluent and its social and ambient implications and by the valorization of by-products of the process as it is the case of fertilizers or the production of electricity from biogas.

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