Treatment of phenolic compounds in Olive Mill Wastewater and lowering the phytotoxicity of effluent

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Olive mill wastewater (OMWW) management is a serious environmental issue for the Mediterranean area where there is the most production of olive oil. OMWW is dark colored, foul smelling and turbid. OOMW has a complex composition and contains a large number of organic compounds depending on the extraction process used. But in all cases, OMWW is characterized by high concentrations of BOD5 (35-100 g/l), COD (40-195g/l) and phenolic compounds. The dark color comes from lignin components polymerized with phenolic compounds in different ways (Canizares, P., Lobato, J., et. al., 2007).

OMWW usually has a pH of 4.0 to 6, 0.3-23g/l of lipid, with a total organic matter of 40-165g/l and mineral matter of 5-14g/l (Niaounakis, M., Halvadakis, C.P., 2006). The organic fraction of OMWW includes hydrocarbons, long chain fatty acids, and various phenolic compounds. There are nitrogen containing compounds, organic acids, pectins, tannins, polyphenols, polyalcohols, and lipids. The final chemical composition depends on oil extraction procedure, fruit maturation, storage time and so forth.

This wastewater is characterized by a significant toxicity to aquatic and terrestrial organisms because of its high organic load, low biodegradability, and elevated concentrations of phenol components. Phenolic compounds being responsible for several biological effects including antibiosis and phyto-toxicity make OMWW biological treatment problematic.

Phenolic compounds are present in OMWW at concentrations in the range from 0.5 to 24 g/l and are strictly dependant on the processing system used for olive oil production. The prevalent classes of hydrophilic phenols identified in OMWW include phenolic alcohols, phenolic acids, phenyl alcohols, and lignins. So far, more than 30 phenolic compounds have been identified in OMWW. These phenolic compounds can be categorized based on the parent compound which phenols were derived from including cinnamic acid derivatives and benzoic acid derivatives.

In a recent study (Isidori, M., Lavorgna, M., et. al., 2005) concerning the toxicity of OMWW fractioned by ultrafiltration and reverse osmosis techniques on aquatic organisms, the most toxic fraction was that from reverse osmosis (RO) containing compounds of low molecular weight (<350 Da). That investigation also provided evidence that the high toxicity was prevalently due to catechol and hydroxytyrosol, the most abundant compounds of RO and constantly present in OMWW.

Traditionally, OMWW was discharged into nearby rivers and streams which has had a considerable impact on the receiving waters. Discharges of OMWW in natural waters

decreases the amount of dissolved oxygen in water and causes harm to aquatic species. Additionally, the phosphorus compounds in OMWW increases the algae and increase cause eutrophication, destroying the whole ecological balance of natural waters.

In wastewater treatment plants, OMWW with its high acidity and suspended solid content is very corrosive to the sewer pipes and cause extensive damage to sewerage system. Also suspended solids settle in the sewers close the mill's discharge pipes and sedimentation build up. Cytotoxicity of phenolic compounds causes damage to activated sludge units (Niaounakis, M., Halvadakis, C.P., 2006).

The purpose of this study is to improve OMWW treatment by reducing its phenolic concentration. This treated wastewater can be used for agriculture purposes or be discharged into urban sewage system and undergo the general waste treatment in the treatment plant. Reducing phyto-toxiciy and bacteria toxicity of OMWW can be achieved by using two separate procedures: By degradation of phenolic compounds through advanced oxidation process using electron beam irradiation and/or by recovery of phenolic compounds.

Electron beam irradiation is an advanced oxidation-reduction process using hydroxyl radical oxidizing effects and solvent electron's reduction potential. Employing Cobalt-60 irradiation, a chain reaction starts by producing hydroxyl radicals which will attack organic molecules and creating organic radicals.

The suggested method for extracting phenolic compounds from OMWW should be simple and economical and can be used for small traditional mills as well as more modern operations. Selective concentration by ultra-filtration and reverse osmosis seems a likely candidate.

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