BIOTECHNOLOGIES FOR THE SUSTAINABLE PRODUCTION OF BIOPOLYMERS AND THE DEGRADATION/VALORIZATION OF CONVENTIONAL PLASTICS AND MICROPLASTICS

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The research has the objective of finding solutions to the environmental problems linked to the production and consumption of plastics, which are obtained on the industrial scale from fossil sources and accumulate in the environments in which they are disposed, because of their scarce biodegradability. To this aim, the exploitation of renewable resources for the production of microbial biodegradable biopolymers, which could replace conventional plastics in defined applications, can represent a strategic approach. In particular, polyhydroxyalkanoates (PHAs) are polyesters, which are stored by several aerobic bacteria as a carbon and energy source under a metabolic stress due to the lack of one or more nutrients. To date, PHAs are industrially produces by employing sugars obtained from dedicated crops. The research objective is the substitution of such substrates with typical wastes of the Mediterranean basin, such as olive mill wastewaters and winery waste. The residue organic material has to be converted in volatile fatty acids (VFAs) within acidogenic anaerobic digestion processes.

The biodegradation/valorization of waste plastics represents a further possible strategy to the aims describes above. The research activity deals with the development of experimental procedures for the selection of novel and robust microorganisms, both as pure cultures and mixed consortia, able to attack polyethylenes, polypropylenes, polystyrene and polyvinyl chloride. For this purpose, actual-site aged plastic wastes obtained from landfills, terrestrial and marine sites will be utilized as sources of microorganisms potentially able of biodegrading plastics. Such microorganisms will be isolated and their biodegradation activity will be compared with those of private pure bacterial strains purchased from public culture collections. The opportunity to have controlled depolymerization of some polymers by selected enzymes to get oligomers to be reused in new or hydrid polymer production is also being evaluated.

Fig. 1. PHA film obtained by chemical extraction of the polymer from *C. necator* culture

Fig. 2. Anaerobic microcosms for the enrichment of microbial communities from waste plastics able to degrade synthetic polymers.

MAIN PUBLICATIONS

Scoma A., Bertin L., Fava F. (2013). Effect of hydraulic retention time on biohydrogen and volatile fatty acids production during acidogenic digestion of dephenolized olive mill wastewaters. *Biomass and Bioenergy* 48, 51-58.

Raddadi N., Crotti E., Rolli E., Marasco R., Fava F., Daffonchio D. (2012). The most important Bacillus species in biotechnology. In ESTIBALIZ SANSINENEA. *Bacillus thuringiensis* Biotechnology. p. 329-345, Max Haring-Springer press, Netherlands.

Giacomucci L., Toja F., Sanmartín P., Toniolo L., Prieto B., Villa F., Cappitelli F. (2012). Degradation of nitrocellulose-based paint by *Desulfovibrio desulfuricans* ATCC 13541. *Biodegradation*, 23, 705–716.

Scoma A., Bertin L., Zanaroli G., Fraraccio S., Fava F. (2011). A physicochemical–biotechnological approach for an integrated valorization of olive mill wastewater. *Bioresource technology* 102, 10273-10279.

Bertin L., Lampis S., Todaro D., Scoma A., Vallini G., Marchetti L., Majone M., Fava F. (2010) Anaerobic acidogenic digestion of olive mill wastewaters in biofilm reactors packed with ceramic filters or granular activated carbon. *Water Research* 44, 4537-49.

Beccari M., Bertin L., Dionisi D., Fava F., Lampis S., Majone M., Valentino F., Vallini G., Villano M. (2009). Exlopiting olive mill effluents as a renewable resource for production of biodegradable polymenrs through a combined anaerobic-aerobic process. *J. Chem. Technol. Biotechnol*. 84(17), 901-908.

RESEARCH PROJECTS

EU FP7-KBBE-2012.3.5-02 Project ID. 312100: BIOCLEAN (New BIOtechnologiCaL approaches for biodegrading and promoting the environmEntal biotrAnsformation of syNthetic polymeric materials)

EU FP7-KBBE-2010-4 Project ID. 266473: ULIXES (Unravelling and exploiting Mediterranean Sea microbial diversity and ecology for xenobiotics' and pollutants' clean up).

EU FP7-KBBE-2010-4 ID. 265669 Project: ECOBIOCAP (Ecoefficient Biodegradable Composite Advanced Packaging).

EU FP7-2012-ID 311933 Project: WATER4CROPS (Integrating bio-treated wastewater with enhanced water use efficiency to support the Green Economy in EU and India).

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