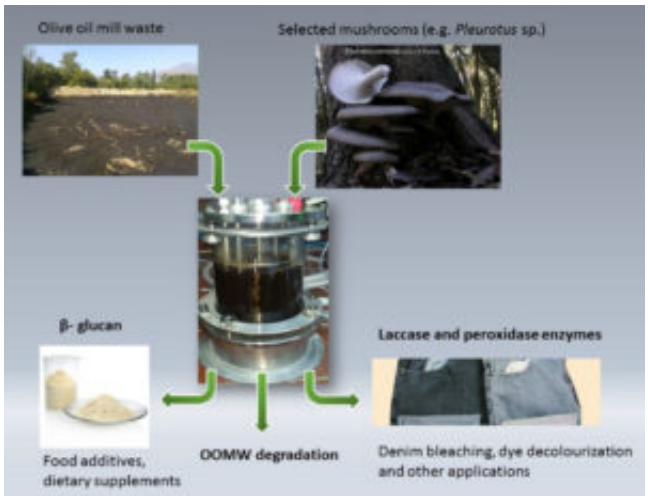
From toxic wastes to valuable products: valorization of olive oil mill wastewater using mushrooms

Global olive oil production amounts to 2952 thousand tons, of which 71.7% is produced in Europe. Olive oil is a necessary dietary supplement, with various commonly known benefits for human health; however, its production process leads also to the production of toxic wastes. Olive oil mill wastewater (OMWW) is the main by-product of olive oil production and it poses a serious environmental threat, due to its high toxicity against plants and soil microorganisms that is attributed to its high concentration in phenolic and other organic compounds. Biological treatment of OMWW is an environmentally friendly alternative to the popular physicochemical techniques used today. Biological approaches consist of the cultivation of a suitable microorganism using OMWW as the carbon and energy source, alone or in a mixture with other substrates. White-rot basidiomycetes, such as *Pleurotus ostreatus,* a popular edible mushroom, were shown to efficiently degrade and detoxify OMWW while producing valuable biomass, enzymes and other products. These fungi accomplish the degradation of OMWW with the production of various enzymes, widely used in industrial applications, such as the manufacturing or degradation of dyes, pulp and paper industry, or in the clarification of fruits juice. Aside from the production of enzymes, biological treatment could result in the production of compounds, such as ?-glucans, with pharmaceutical and/or nutritional value leading to the valorization of a toxic waste. ?-Glucans in particular, are becoming increasingly popular in the food industry, where they are used as additives, due to their stimulating action on the human immune system, but also due to their anti-cholesterolaemic effects.



Valorization of olive oil mill wastewater with the use of selected mushroom fungi.

In the present study, we used two mushroom species, *Pleurotus citrinopileatus* and *Irpex lacteus*,

for cultivation in OMWW, aiming to obtain the detoxification of the waste, together with the production of valuable products. Our results show that a number of parameters must be regulated for the waste degradation to be efficient: Firstly, the pH of OMWW must be adjusted to 6. Secondly, the agitation of the cultures must be precisely adjusted in order to obtain sufficient aeration of the culture, and also to avoid mechanical shearing of the growing mycelia. Thirdly, and most importantly, the addition of a nitrogen source is required for the proper growth of the fungal biomass. In our work we tested a variety of nitrogen sources, the best of which was found to be corn steep liquor (CSL), also an important low cost by-product of the corn processing industry, for the growth of *P. citrinopileatus,* while diammonium tartrate was found to be the best supplement for *I. lacteus*. Addition of these nitrogen-rich compounds resulted in over 90% decolourization and decrease of the phenol's content of OMWW by both fungi. At the same time, we observed the significant production of valuable enzymes, such as laccases, yielding up to 7778 enzyme Units L^{-1}, and peroxidases, yielding up to 675 enzyme Units L^{-1}.

The fungal biomass formed during growth in OMWW were analyzed for ?- and ?- glucan content. The results were very satisfactory: For *P. citrinopileatus* ?-glucan content was 11 % w/w, while mushrooms from *I. lacteus* were found to contain 6 % w/w ?- glucans. These results are very promising in respect to the valorization of a toxic waste through the production of valuable polysaccharides.

	Total glucans	α- glucans	β- glucans
Pleurotus citrinopileatus	14.05% w/w	3.12% w/w	10.93% w/w
Irpex lacteus	6.28% w/w	0.41% w/w	5.87% w/w

Total, ?- and ?- glucan content of fungal biomass formed during degradation of OMWW.

In conclusion, both strains performed equally well in the degradation of OMWW. The produced enzymes could possibly be further exploited in biotechnological applications, such as dye decolourization/textile dye effluents decolorization. Basidiomycete biomass formed during the detoxification of OMWW could also be exploited for the isolation of ?-glucans, thus leading to the valorization of the waste.

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Degradation of olive mill wastewater by the induced extracellular ligninolytic enzymes of two wood-rot fungi.
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