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Organic matter transformation and detoxification in dry olive mill residue by the saprophytic fungus *Paecilomyces farinosus*

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ABSTRACT

Dry olive mill residue (DOR), the by-product of the two-phase extraction process, is very rich in organic matter and nutritionally relevant cations. For this reason, the agronomic use of this waste has been suggested although DOR exhibits significant phytotoxicity. The objective of this study was to investigate the impact of *Paecilomyces farinosus* on both organic matter modification and detoxification of this waste. Humification ratio in DOR colonized by the fungus for 20 weeks was increased by about 65% with respect to the abiotic control and humification index reached 0.38, a value that characterizes well-humified materials. High performance size-exclusion chromatography of humic acids from fungal cultures showed a marked increase in both weight-averaged and number-averaged molecular weights with respect to abiotic controls. Water-soluble phenols were reduced by 45% in 20-week-old *P. farinosus* cultures on DOR and mass-balance ultra-filtration showed that the relative abundance of the molecular weight fraction of phenols above 30 kDa increased from 31 to 72% suggesting the occurrence of polymerization. Experiments performed with alfalfa grown on soils containing 2.5% (w/w) of abiotic controls and fungal-treated DOR showed that phytotoxicity was totally suppressed in the waste that underwent fungal treatment.

1. Introduction

The olive oil extraction industry that was formerly confined within the Mediterranean area is gaining an ever increasing economic and social relevance at a worldwide level. Large quantities of both solid and liquid wastes are generated by the olive oil manufacturing process [1]. As a consequence, olive oil producing countries are facing severe environmental contamination problems caused by the accumulation and/or incorrect disposal of these wastes.

In recent years a new two-phase extraction process was introduced in modern mills. In Spain, the most important olive oil producer in the world, the introduction of this technology was carried out in 90% of Spanish olive oil factories [1]. This process generates two fractions: the olive oil and a solid waste often referred to as "pomace" or "alperoujo" characterized by a high moisture content [2]. This solid waste is generally dried and subjected to a subsequent extraction with *n*-hexane to recover residual oil thus leading to the formation of a solid waste, termed dry olive mill residue (DOR), the annual production of which amounts to around 4 million tonnes [3]. This by-product has been so far mainly employed for energy and co-generation purposes, although some perplexities have been raised due to the presence of polyaromatic hydrocarbons in combustion gases [1]. The agronomic use of DOR has been also suggested, due to its high concentration in both organic matter and nutritionally important cations, such as potassium and calcium. However, the organic fraction includes toxic compounds such as polyphenols, polyalcohols and volatile fatty acids [1,2] capable of inhibiting both microbial growth [4] and germination and morphogenesis in plants [5]. Consequently, DOR has to be stabilized and detoxified prior to its application into soil. In this respect, successful results have been obtained by subjecting DOR to composting or co-composting with other agro-residues [5,6]. A possible alternative to composting might involve the inoculation with saprobe fungi able to both stabilize the waste and to degrade phytotoxic

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