RISK ELEMENT SORPTION CHARACTERISTICS IN SOIL TREATED BY BIOLOGICALLY TRANSFORMED DRY OLIVE RESIDUE (DOR)

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Introduction

Olive oil production is one of the most relevant agroindustrial activities in the Mediterranean region and generates a huge amount of both solid and semi-solid wastes, the uncontrolled disposal of which might lead to serious environmental problems. Due to its organic matter and mineral nutrient content, the dry olive residue (DOR) can be used as organic fertilizer, but it can not be directly applied to soil because of its phytotoxic properties. The biological fungal transformation of DOR can effectively stabilize the organic matter content, enhance C/N ratio and substantially reduce the phenolic fraction content in the waste (Sampedro et al., 2009). In this study, the sorption ability of DOR for two risk elements (Pb, Cd) was assessed to estimate: i) the sorption potential of DOR to change the sorption characteristics of soil, and ii) the effect of the fungal transformation of DOR on the sorption effectivity of this material.

Methods

The DOR sample used in this experiment was supplied by olive oil manufacturer Sierra Sur S.A. (Granada, Spain). The DOR was sieved, autoclaved in three cycles and stored at 4 ºC before use. Its principal characteristics have previously been described by García-Sánchez et al. (2012). The DOR samples were transformed by four species of fungi for three weeks: *Penicillium chrysogenum* – labeled DORPC; *Coriolopsis floccosa* – labeled DORCF; *Bjerkhandera adusta* – labeled DORBA; and *Chondrostereum purpureum* – labeled DORCP. The soil used in this experiment was a sandy Fluvisol characterized by the low contents of risk elements (0.1 mg/kg of Cd, and 11.2 mg/kg of Pb). This soil had a cation exchange capacity (CEC) of 33.3 mmol/kg, pH 6.6 and a content of oxidized carbon (Cox) 3.36%. For the experiments, the DOR and DOR transformed by fungi samples were mixed with the soil in ratio 1:1. Batch sorption experiments were performed by equilibration of 0.5 g of the prepared mixture with 15 ml of metal solutions in 0.01 mol/l solution of $NaNO_3$ at 150 rpm at room temperature for 24 h. The initial concentrations of Cd, and Pb were: 0.04, 0.1, 0.2, 0.4, 1, 2, 4, 6 and 8 mmol/l (individually). The suspensions were centrifuged for 10 min at 5400 rpm, and the supernatants were immediately measured. The concentrations of Cd, and Pb in the solutions were determined by ICP-OES. Freundlich and Langmuir isotherms were used for an assessment of the sorption capacity of the materials.

Results

The parameters derived from the fitting of the sorption isotherms of elements with the Freundlich and Langmuir equations are summarized in Table 1. In all the cases, DOR application enhanced substantially the sorption characteristics compared to the soil. For Cd, the biological fungal transformation of DOR resulted in higher sorption ability compared to the non-transformed DOR. Higher pH level (5.0-5.7) of the transformed DOR than the non-transformed DOR (pH = 4.8) could play an important role in this context. The highest sorption capacity, as measured by the S_{max} value, was reported for non-transformed DOR and *B. adusta* (DORBA) transformed DOR in the case of Pb, and for *C. purpureum* (DORCP) and *C. floccosa* (DORCF) transformed DORs in the case of Cd.

Table 1. Parameters derived from the fitting of the sorption isotherms of elements with the Freundlich and Langmuir equations

	Freundlich			Langmuir		
	E	K_F	N	E	K_L	S_{max}(mmol/kg)
Lead						
Soil	0.950	8.00	0.208	0.933	0.481	25.6
Soi+DOR	0.970	75.6	0.555	0.997	0.687	136
Soil+DORPC	0.949	61.1	0.410	0.994	1.966	115
Soil+DORCF	0.903	45.4	0.359	0.961	2.975	79.2
Soil+DORBA	0.929	66.9	0.438	0.984	1.631	132
Soil+DORCP	0.836	63.1	0.333	0.965	3.132	106
Cadmium						
Soil	0.912	12.4	0.272	0.991	7.42	16.2
Soi+DOR	0.921	16.9	0.378	0.998	3.15	26.4
Soil+DORPC	0.963	55.2	0.355	0.989	2.55	96.9
Soil+DORCF	0.937	50.7	0.421	0.994	1.47	104
Soil+DORBA	0.962	36.9	0.341	0.995	2.65	64.4
Soil+DORCP	0.989	41.4	0.525	0.989	0.67	118

Conclusion

The biological fungal transformation of DOR showed good potential for sorption of risk elements, especially Pb, and therefore could be considered as a potential material suitable for the immobilization and stabilization of this element in contaminated soil. However, the long-term stability and effectivity of DOR-element bounds in the contaminated soil as well as the different response of the individual elements on the DOR application needs to be evaluated in the further research.

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