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XENOBIOTICS PERSISTENCE IN MEDITERRANEAN SOIL: EFFECTS OF COMPOST APPLICATION ON THEIR DISSIPATION

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INTRODUCTION & AIM

This study explores the idea that organic xenobiotics can persist in Mediterranean agricultural soils, and that biowaste compost may help accelerate their dissipation (Figure 1).

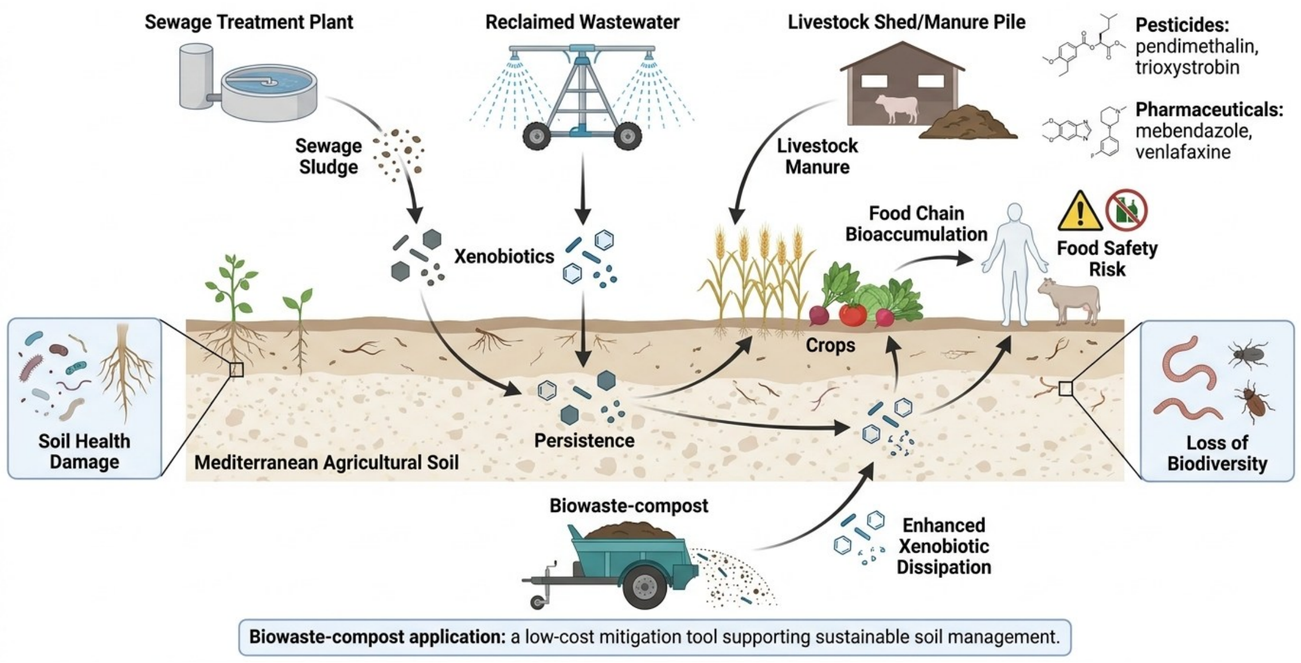

Figure 1: Soil pollution by organic Xenobiotics en mediterranean agroecosystems: sources, risks and mitigation.

The aim of this study was to compare the persistence of two pesticides (pendimethalin, trioxystrobin) and two pharmaceuticals (mebendazole, venlafaxine) in a Mediterranean agricultural soil, and to assess whether biowaste-compost application enhances the dissipation of these xenobiotics under controlled microcosm conditions QuEChERSER extraction and UHPLC-MS/MS quantification.

METHOD

A calcareous loamy-clay Mediterranean soil (Alfisol) from eastern Spain was sampled, characterised and used to set up laboratory microcosms. Treatments consisted of contaminated soil without amendment and contaminated soil amended with biowaste compost at agronomic rates. Pendimethalin and trifloxystrobin were selected as model pesticides, while mebendazole and venlafaxine represented veterinary and human pharmaceuticals with contrasting physicochemical properties. Contaminant concentrations were monitored over 21 days of incubation (Figure 2).

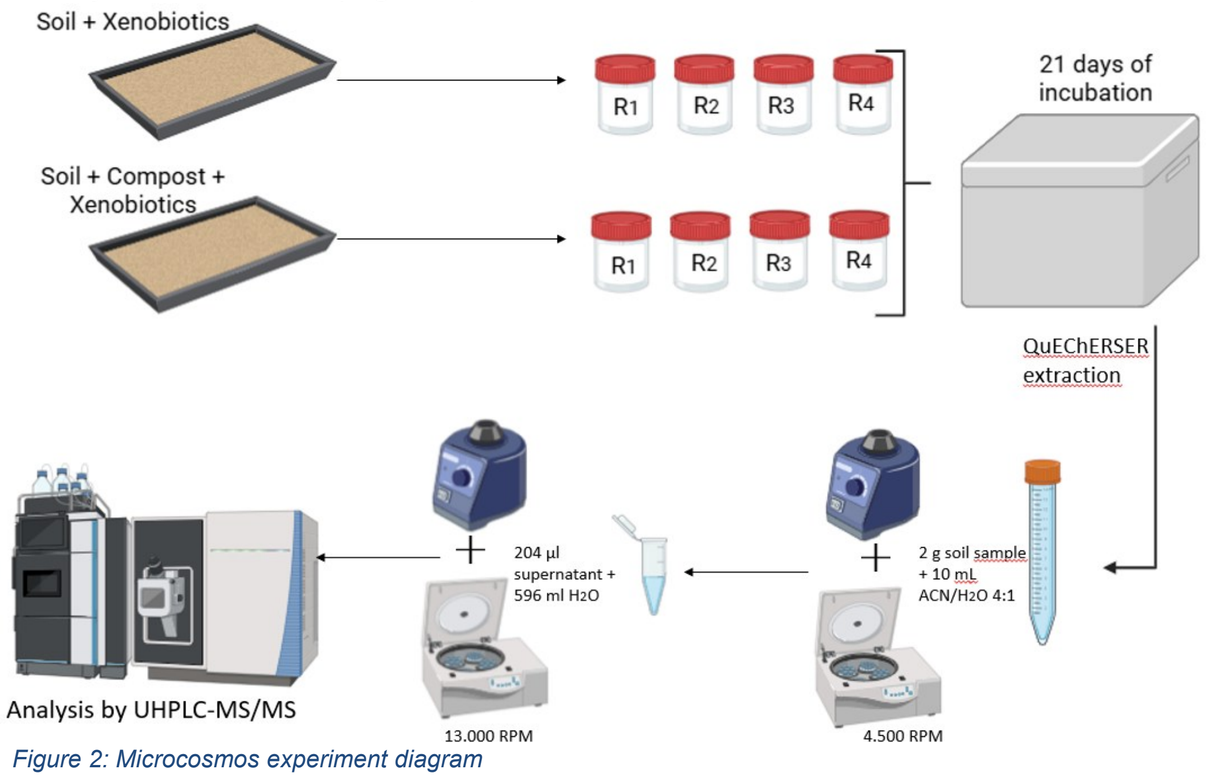

Figure 2: Microcosmos experiment diagram

Soil samples were extracted using the QuEChERSER mega-method and analysed by UHPLC-MS/MS (Monteiro et al., 2021; Boluda et al., 2025). First-order kinetic models were fitted to concentration–time data to estimate dissipation rate constants and half-life values, allowing comparison of persistence between compounds and between amended and non-amended soils

RESULTS & DISCUSSION

Pendimethalin showed moderate dissipation in unamended soil ($t_1/_2$ ≈ 63 d), which was clearly accelerated by compost (33 d). Trioxystrobin was rapidly degraded in all treatments ($t_1/_2$ ≈ 5 d), and amendment only slightly increased its dissipation. Mebendazole was highly persistent in soil (173 d), but compost reduced its half-life to about 63 d, while venlafaxine scarcely dissipated without amendment and only showed measurable degradation when compost was applied ($t_1/_2$ ≈ 63 d) (Figure 3, Table 1).

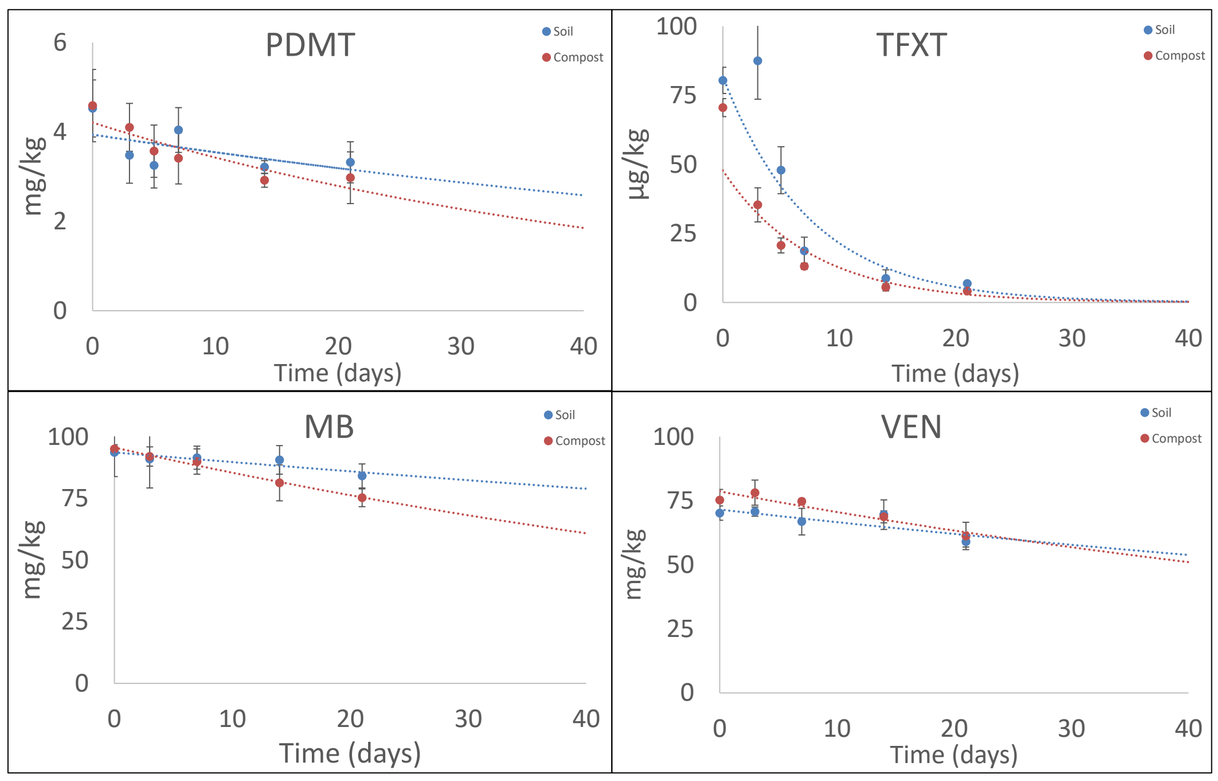

Figure 3: Xenobiotics dissipation during experiment

Overall, these patterns indicate that biowaste compost consistently enhances xenobiotic dissipation in this Mediterranean soil, reducing half-lives for pendimethalin, mebendazole and venlafaxine compared with the unamended treatment. This behavior is strongly compound-dependent: rapidly degradable molecules such as trioxystrobin show only minor additional benefits, whereas highly persistent pharmaceuticals respond much more markedly to compost addition. These results support the use of quality organic amendments as a promising bioremediation tool in intensively managed Mediterranean agroecosystems, while highlighting the need for compound-specific assessments when designing soil remediation strategies.

Table 1: Half-life times of xenobiotics according to first-order kinetics equation.

	PDMT		TFXT		MB		VEN	
	Soil	Compost	Soil	Compost	Soil	Compost	Soil	Compost
T1/2 (days)	-	33.0	5.2 a	5.2 a	173.2 a	63.0 b	-	63.0

CONCLUSION

This work shows that xenobiotic persistence in Mediterranean soils is highly variable across chemical classes, and that biowaste compost can reduce the half-life of both pesticides and pharmaceuticals under controlled conditions. Pendimethalin, mebendazole and venlafaxine all exhibited shorter half-lives after compost addition, whereas trioxystrobin remained rapidly degradable with or without amendment.

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