Quality Standards for Urban Waste Composts: the need for biological susceptibility data

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1. Introduction

The Circular Economy Package intends to boost the production and EU movement of fertilizing products, such as composts obtained from urban wastes (UWC) and the harmonization of quality standards (certification) for such products, to avoid market rejection (EC, 2015).
There is evidence that the application of UWC in soil improves its structure and fertility (Hargreaves et al, 2008). However, information on these and other benefits, as well as on the management of potential environmental risks associated with such practices is unclear, especially among potential end-users. These risks include the release of toxic compounds (eg associated with low stabilization) and contaminants (eg, salt, metals, POPs or nitrates) affecting crops, terrestrial and aquatic ecosystems, but also human health (Fagnano et al, 2011), in addition to the lack of uniformity between batches.
The EU fertilizer regulation is currently under review and organic products, such as UWCs, will be included for the first time (Ţurcanu, 2017). However, the Portuguese (Decree-Law 103/2015) and EU latest proposal on regulation of UWC production/commercialization (Saveyn & Eder, 2014) relies only on physic-chemical/biochemical analysis, which do not give any insight on the fraction of contaminant/mixture of contaminants bioavailable for organisms, nor the existence of potential antagonistic and/or synergistic effects (Renaud et al, 2017).
The objective of the present contribution is to evaluate the impact of the application of five UWCs in the soil, using ecotoxicological tests with representative organisms. This work is part of a project which main objective is to develop an environmental quality certification system for the use of UWCs in agricultural systems.

2. Materials and Methods

Five UWC commercially available in Portugal were selected: three derived from Mechanical Biological Treatment (MBT) of the organic fraction of mixed urban waste (class IIA, Decree-Law 103/2015), hereafter designated as A, B and C; two from composting of source-separated organic wastes (SSW; class I, Decree-Law 103/2015), hereafter designated as D and E. For all tests, an increasing gradient of UWC dilutions (0.7, 2.1, 6.3, 18.9 e 56.7% of UWC; dry mass) was prepared in laboratory with a natural uncontaminated soil collected in Coimbra surrounding. The lowest dilution (0.7%) corresponds to the Annual Recommended Dosage for class IIA UWC, according to the Portuguese Legislation (10t/ha; Decree-Law 103/2015) and the following ones intended to simulate scenarios of overuse or excessive application. Five test-species, namely three soil invertebrates (earthworms, collembolans and enchytraeids) and two plant species (lettuce and wheat), representative of different trophic levels and exposure routes were exposed to the gradient of UWC dilutions, according to ISO/OECD guidelines. The endpoints measured were avoidance behavior, lethality and reproduction, for soil invertebrates plus seed germination and plant growth, for plant tests (see Table 1). Physico-chemical characterization of UWCs was also performed. Significant differences between the performance of organisms in control and UWC dilutions were checked using One Way Anova and Dunnet test. The UWC dilutions causing 50% of decline (EC50s) in either reproduction or biomass production were also calculated using non-linear regressions.

3. Results and Discussion

Reproduction tests with earthworms (Figure 1) have demonstrated that, at low doses (0.7 and 2.1%), the composts appear to be beneficial for this species, often used in organic waste composting. However, for all UWCs, with the exception of E, almost no juveniles were found at two highest doses. It is also important to highlight the differences found between the UWC D and E, both originated from SSW, which were, respectively, the most and least toxic of the five tested. This same pattern of toxicity was observed in the other tests, as shown in Table 1. Of the 3 UWCs resultant from TMB, UWC A presented a higher risk associated with its application to soil. Plants and earthworms were, respectively the least and most sensitive test-organism.

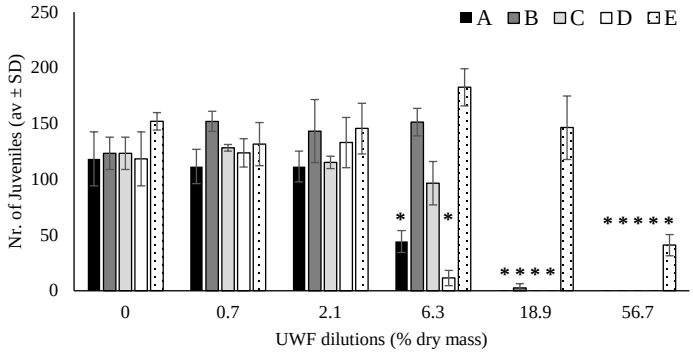

Figure 1: Effects (average ± standard deviation) of different soil dilutions of five UWCs on the reproduction of the earthwom *E. andrei.* * - Statistically lower than the respective control (One Way ANOVA, Dunnet Test, $p<0.05$).

Table 1. Standard Ecotoxicological tests carried out on the UWC-soil dilutions and respective levels of toxicity, sorted in descending order (1 - highest toxicity; 5 - lower toxicity). A, B, C – UWC originated from MBT B; D, E – UWC originated from SSW.

Test-specie	Common name (Taxonomic group)	Endpoint	UWC toxicity				
			A	B	C	D	E
Lactuca sativa	Lettyuce (Magnoliophyta)	Germination/Growth	2	3	4	1	5
Triticum aestivum	Wheat (Magnoliophyta)	Germination/Growth	2	3	4	1	5
Folsomia candida	Springtails (Arthropoda)	Avoidance	1	5	2	3	4
		Reproduction	4	2	3	1	5
Enchytraeus crypticus	Enchytraeids (Annelida)	Reproduction	2	4	3	1	5
Eisenia andrei	Earthworms (Annelida)	Avoidance	2	4	3	1	5
		Reproduction	2	4	3	1	5

4. Conclusions

The overall results demonstrated that the soil application of UWC within (or slightly above) the recommended dosages (according to the Portuguese legislation) could be beneficial for plants and soil invertebrates. Unexpectedly, the UWC showing higher environmental concern was originated from source separated organic wastes, and theoretically, should be of superior quality. The gathered data thus highlight the need to include the biological susceptibility of potential receptors at risk on the available regulation, to safeguard both agricultural fertility, food safety and environmental quality and to adapt the UWC application practices. The evaluation of the application of some of these UWCs under more realistic conditions (field trials), including the food safety component, will consolidate a future proposal for environmental certification.

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